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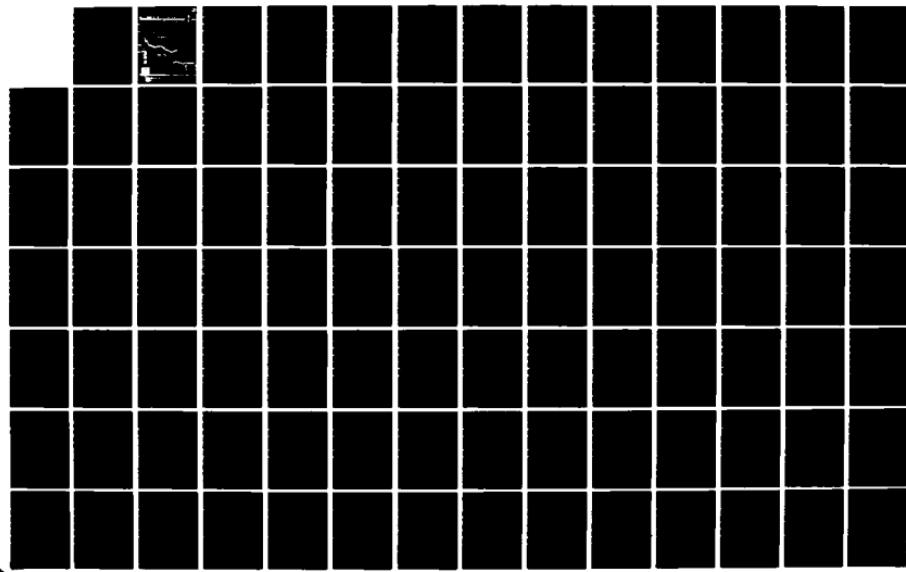
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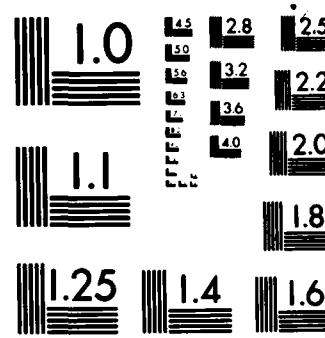
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problems, to determine priorities for immediate and longrange action, and to identify the capabilities of various governmental units for implementing the actions.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

The Roseau River Subbasin occupies 1,128 square miles of the northern Minnesota portion of the Red River Basin and an additional 929 square miles in Canada. Altogether, it is one of the larger subbasins, including portions of Kittson, Roseau, Marshall, Beltrami, and Lake of the Woods counties in the United States and Manitoba Province in Canada. It is bordered on the southeast by the Red Lake River Subbasin and on the southwest by the Two Rivers and Main Stem subbasins. The area is unique because it is one of the two subbasins that reaches into Canada. The United States portion of the subbasin has achieved a legal status through the formation of the Roseau River Watershed District. Because of the geographic location of the subbasin, much of the water resource planning for the subbasin has been done under the auspices of the International Joint Commission.

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Final Report

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**RECONNAISSANCE REPORT:
RED RIVER OF THE NORTH BASIN,
ROSEAU RIVER SUBBASIN**

Prepared for:

U.S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota



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TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
I	THE STUDY AND REPORT.	1
II	DESCRIPTION OF STUDY AREA	3
III	PROBLEMS, NEEDS, AND DESIRES.	6
	Flooding Problems.	6
	Nature of the Problems.	6
	Location and Extent	7
	Flood Damages	9
	Environmental Concerns	11
	Recreational Problems.	12
	Water Quality Problems	13
	Water Supply Problems.	13
	Erosion Problems	13
	Irrigation	14
	Wastewater Management.	14
	Hydropower	16
	Public Perception of Problems and Solutions.	16
IV	DESCRIPTION OF SUBBASIN RESOURCES	18
	Social Characteristics	18
	Economic Characteristics	19
	Employment.	19
	Income.	19
	Business and Industrial Activity.	20
	Transportation Network.	22
	Land Use.	22
	Environmental Characteristics.	22
	Climate	22
	Geology	23
	Biology	23
	Water Supply.	29
	Water Quality	31
	Aesthetics.	34
	Cultural Elements	34
	Recreational Resources	36
	Significant Environmental Elements	37
	Social.	37
	Cultural.	39
	Soils	39

TABLE OF CONTENTS (Cont'd)

<u>Section</u>		<u>Page</u>
	Water	39
	Woodlands	39
	Wetlands.	41
	Waterfowl Production Areas.	41
	Wildlife Management Areas	41
	Threatened or Endangered Species.	42
	Other Important Species	42
	Natural Areas	44
V	FUTURE CONDITIONS	45
	Most Probable Economic Conditions.	45
	Most Probable Agricultural Conditions.	47
	Evaluation of Flood Damages--Future Conditions	47
	Most Probable Environmental Conditions	50
	Without Project Conditions	50
VI	EXISTING FLOODPLAIN MANAGEMENT PROGRAMS	51
	Institutions	51
	Structural Measures.	51
	Nonstructural Measures	52
	Adequacy of Existing Measures.	55
VII	CRITERIA AND PLANNING OBJECTIVES.	56
	Floodplain Management Criteria	56
	Planning Objectives.	56
VIII	FORMULATION OF ALTERNATIVE MEASURES	58
	Authorized Measures.	58
	Alternative Measures	61
	Nonstructural Measures	61
IX	ASSESSMENT OF ALTERNATIVES.	63
	Economic Assessment.	63
	Impact Assessment.	63
	Channel Improvements and Levees	63
	Farmstead Levees.	67
X	EVALUATION.	68
XI	ADDITIONAL STUDY NEEDS.	69

TABLE OF CONTENTS (Cont'd)

<u>Section</u>	<u>Page</u>
BIBLIOGRAPHY.	72
Appendix A: FLOODPLAIN DELINEATION	A-1
Appendix B: INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS) ROSEAU RIVER SUBBASIN	B-1
Appendix C: COMMENTS	C-1

LIST OF TABLES

<u>Table Number</u>		<u>Page</u>
1	Roseau River Subbasin, Estimated 1979 and Average Annual Urban Flood Damages.	10
2	Roseau River Subbasin, Estimated 1975, 1979 and Average Annual Rural Flood Damages	11
3	Problems and Needs of Point Source Discharges in the Roseau River Subbasin.	15
4	1978 Crop Statistics, Roseau River Subbasin	20
5	Manufacturing Establishments, Roseau River Subbasin	21
6	Fish and Game Lakes Resources, by Lake Type, in Three of the Four Counties included in the Roseau River Subbasin. .	30
7	Surface Water Quality Data for the Roseau River Near Malung From 1967-1968	32
8	Surface Water Quality for the Roseau River Near Roseau and Caribou, November 1977 to August 1978.	33
9	Groundwater Quality for Six Wells in Roseau County.	35
10	Comparison of County Percentages of Woodland Vegetation Between 1969 and 1977.	40
11	Roseau River Subbasin, Population, Employment, and Per Capita Income Projections, 1980-2030.	46
12	Roseau River Subbasin, Principal Crops and Projected Production, 1980-2030.	47
13	Roseau River Subbasin, Summary of Present and Future Average Annual Damages, Urban, Agricultural, and Transportation. .	48
14	Economic Evaluation of Alternatives	64
15	Assessment of Measures, by Resource Element, Roseau River Subbasin	65

LIST OF ILLUSTRATIONS

<u>Figure Number</u>		<u>Page</u>
I	Roseau River Subbasin.	4
II	100-Year Flood Plain	8
III	Recreational Resources	38
IV	Existing Flood Control Measures.	53
V	Alternative Flood Control Measures	59

I. THE STUDY AND REPORT

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North Study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin.

The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and problems, to determine priorities for immediate and long-range action, and to identify the capabilities of various governmental units for implementing the actions.

The Roseau River Subbasin is a water resource planning unit located in the northern Minnesota portion of the Red River Basin that reaches into Canada. This report describes the social, economic, and environmental resources of the subbasin, identifies the water-related problems, needs, and desires, and suggests measures for meeting the needs, particularly in the area of flood control.

The report was prepared almost entirely on the basis of secondary information. However, some telephone contacts were made to verify information and to acquire a more complete picture of local conditions. Comprehensive reports available on the subbasin include the following: Joint Studies for Co-ordinated Water Use and Control in the Roseau River Basin, Main Report and Appendices A-F, which was published by the International Roseau River Engineering Board in 1975; Final Environmental Impact Statement, Flood Control, Roseau River, which was published by the St. Paul District, Corps of Engineers in 1976; and Coordinated Water Use and Control in the Roseau River Basin, which was published by the International Joint Commission in 1976. Other published sources on the subbasin include:

1. Application for Assistance in Planning and Carrying Out Works of Improvement Under the Watershed Protection and Flood Prevention Act, Duxby Watershed, Roseau County, Minnesota, which was prepared by the Roseau County Soil and Water Conservation District in 1964 and is an application for Federal assistance.

2. Fish and Wildlife Resources of the Roseau River, which was published by the Minnesota Department of Natural Resources, Division of Fish and Wildlife, Ecological Services Section in 1978 and is a report on resources.
3. Investigation of the Roseau River Fish Population, which was prepared in 1978 by Paul C. Marsh and Ira R. Adelman of the Department of Entomology, Fisheries, and Wildlife, University of Minnesota and is an inventory of fish populations in the river.
4. Environmental Impact Assessment of the Roseau River, Minnesota, Flood Control Project, which was prepared by the Institute for Ecological Studies, University of North Dakota, Grand Forks in 1974 and is a report of environmental aspects and plan impacts in the subbasin.
5. Final Report, Intensive Survey and Testing of Two Sites along the Roseau River, which was published by the St. Paul District Corps of Engineers in 1975 and reports on two sites in the subbasin.
6. Final Report, Intensive Archaeological Testing of the Lins Site, which was prepared by Bemidji State University in 1977 and contains information on the Lins Site in the subbasin.
7. U.S. Fish and Wildlife Service, Roseau River Flood Control Project, Roseau County, Minnesota, Special Report, Ecological Services Office, St. Paul, Minnesota, which was published in 1977 and discusses flood control measures in Roseau County.
8. Correspondence to Colonel Forrest T. Gay III, from Charles A. Hughlett, U.S. Fish and Wildlife Service, Twin Cities, Minnesota, which was published in 1977 and introduced the report mentioned above.

II. DESCRIPTION OF STUDY AREA

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The Roseau River Subbasin (Figure I) occupies 1,128 square miles of the northern Minnesota portion of the Red River Basin and an additional 929 square miles in Canada. Altogether, it is one of the larger subbasins, including portions of Kittson, Roseau, Marshall, Beltrami, and Lake of the Woods counties in the United States and Manitoba Province in Canada. It is bordered on the southeast by the Red Lake River Subbasin and on the southwest by the Two Rivers and Main Stem subbasins. The area is unique because it is one of the two subbasins that reaches into Canada. The United States portion of the subbasin has achieved a legal status through the formation of the Roseau River Watershed District. Because of the geographic location of the subbasin, much of the water resource planning for the subbasin has been done under the auspices of the International Joint Commission.

The entire area was once covered by glacial Lake Agassiz, which left behind a rather level plain broken occasionally by beach ridges, sandy outwash deposits, and remnant lakes. The terrain is gently sloping, with elevations ranging from a maximum of about 1,250 feet above mean sea level at the headwaters of the Roseau River to about 780 feet above mean sea level at the mouth of the Roseau River. About 50 percent of the entire subbasin lies between elevations 1,100 and 1,000 feet. Underlying much of the surface are thick sequences of lake silts and clays. Because of the low relief and relative impermeability of the sediments, particularly the clays, the water table is normally high. As a result, peat bogs are a common surface occurrence in localized depressions where they may be as much as 20 feet thick.

The dominant water feature of the area is the Roseau River. The river follows a general northwesterly course over its entire length of about 180 miles. It crosses the border at about the midpoint of its course and enters the Red River at a point about 15 miles downstream from the intersection of the latter stream with the border. In its natural state, Roseau River was characterized by a tortuous alignment over its entire length. However, the river between Roseau Lake and the border

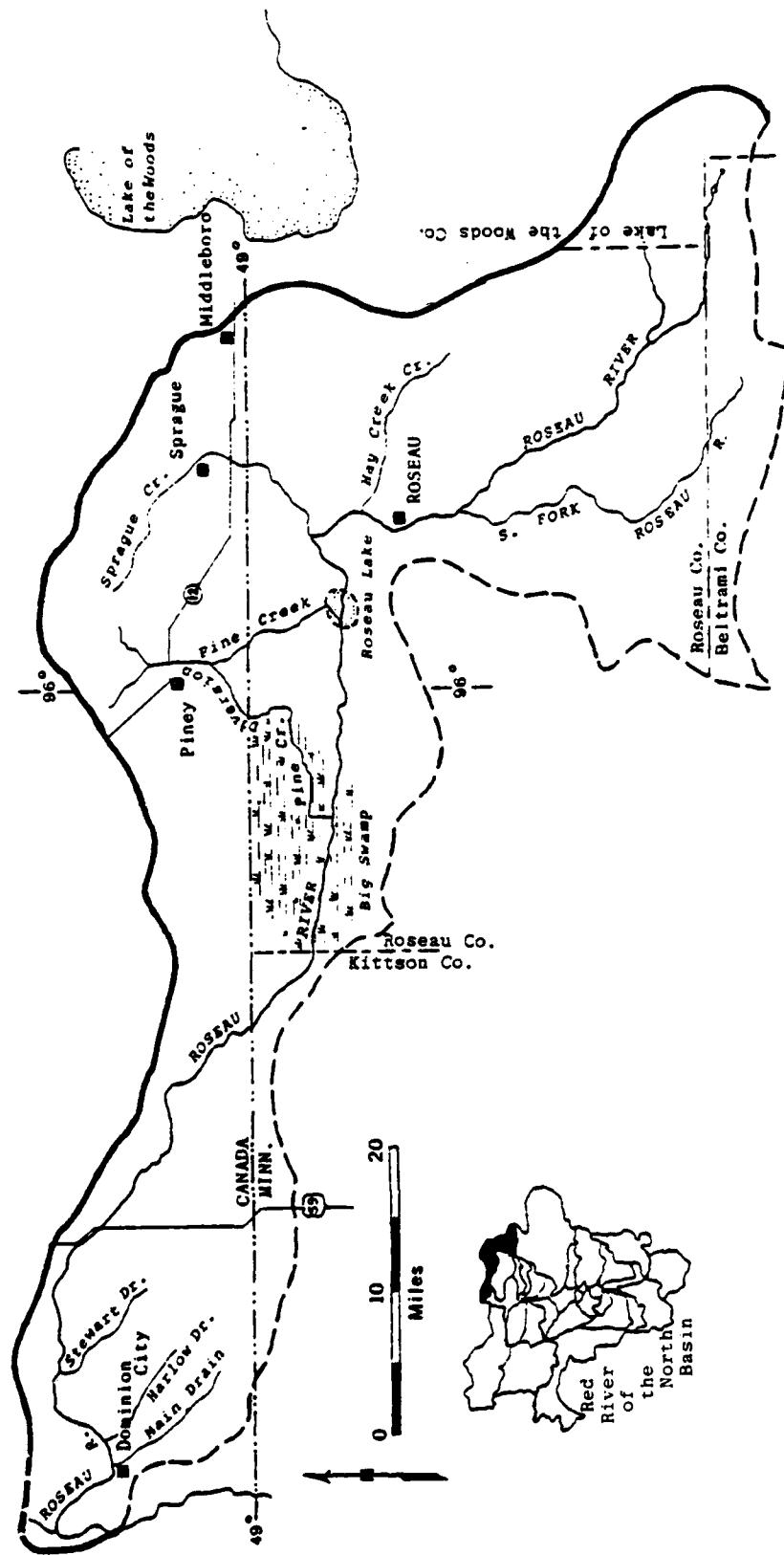


Figure I. ROSEAU RIVERS SUBBASIN

Source: Gulf South Research Institute.

has been straightened. Principal tributaries of the river and their respective drainage areas in square miles are the South Fork (312), Hay Creek (81), Sprague Creek (220), and Pine Creek (90). All enter the main stem within the United States, but Sprague and Pine creeks have their origin and the greater portion of their drainage areas in Canada.

Two other significant features of the subbasin are Roseau Lake and Big Swamp. Roseau Lake lies in an area of peat soils at the focus of the tributary fan just downstream from Roseau. In its natural state, Roseau Lake was a shallow, permanent body of water. Under existing conditions, following construction of lateral ditches and channel enlargement downstream from the lake, Roseau Lake holds water only during flood periods. Thus most of the lake bed is now cropped in nonflood years. During flood periods, the lake has been known to encompass an area of about 40 square miles and serves as a natural retarding basin that regulates runoff from the headwaters tributaries.

Big Swamp, which begins about 10 miles west of the outlet of Roseau Lake, occupies a large portion of the subbasin. The land in this area slopes generally to the southwest; consequently, the portion of the swamp lying north of Roseau River drains into the river, while the area south of the stream, before being modified by ditching, drained away from Roseau River. Lateral ditches in the area have modified natural drainage characteristics to a limited extent; but, nevertheless, during high-flow periods, parts of the flow overtops the south banks of Roseau River within Big Swamp and finds its way overland and through ditches into the several branches of Two Rivers to the south.

Roseau River exhibits a wide range of stream gradients. In the reach above the city of Roseau, a slope of about 17 feet per mile is indicated. Downstream from the village through Roseau Lake and Big Swamp the slope flattens markedly. The minimum slope of the entire stream (about 0.2 foot per mile) is located in Big Swamp. Maximum slope, about 48 feet per mile, occurs in Canada in a reach known as the Roseau River Rapids. At the village of Roseau, the river channel has a depth of about 20 feet and a width of about 125 feet. Between Roseau and the border, channel widths increase gradually to about 170 feet and channel depths range between 10 and 20 feet, except through Big Swamp where the depth reduces to about seven feet. During low flows, water depths can be significantly lower than channel depths.

III. PROBLEMS, NEEDS, AND DESIRES

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The primary water-related problems, needs, and desires in the Red River Basin are flood control, fish and wildlife conservation and enhancement, recreation, water supply, water quality, erosion control, irrigation, wastewater management, and hydropower. Various water-related problems, needs, and desires have been identified for the Roseau River Subbasin in previous planning reports on the basis of analysis of conditions and public and agency comments. The list of problems, needs, and desires for the subbasin is the same as the list for the Red River Basin as a whole with the exception of water supply and hydropower. In addition, erosion is not as serious a problem in this subbasin as in most other subbasins. Each problem is discussed separately below, with an emphasis on flooding problems. The discussion centers on the U.S. portion of the subbasin.

Flooding Problems

Nature of the Problems

Periodic flooding within the subbasin is almost an annual event. Beginning about the second week in April, most spring floods are the result of a combination of heavy winter snowfall and rapid spring melting. These floods force delays in planting operations that are reflected in reduced crop yields. In addition, given the short growing season, water standing on the land too long may make it impossible to engage in planting operations.

Flood damage also occurs from high-intensity summer storms. Although they occur less often than spring snowmelt floods, these summer floods are characterized by high peak flows causing damage to maturing crops or hindering crop harvest. The condition of the soil is an important factor relative to the degree of flooding in that high soil moisture or frozen soil conditions prior to heavy rains and/or snowmelt result in greater runoff.

Two separate types of flooding occur: the most damaging type associated with river bank overflow (overbank flooding) and another type caused

by runoff from snowmelt or heavy rainfall impounded by plugged culverts and ditches within sections of land bounded by roadways on earthen fill (overland flooding). In overland flooding, the trapped water slowly accumulates until it overflows the roadways and inundates section after section of land as it moves overland in the direction of the regional slope until reaching river or stream channels.

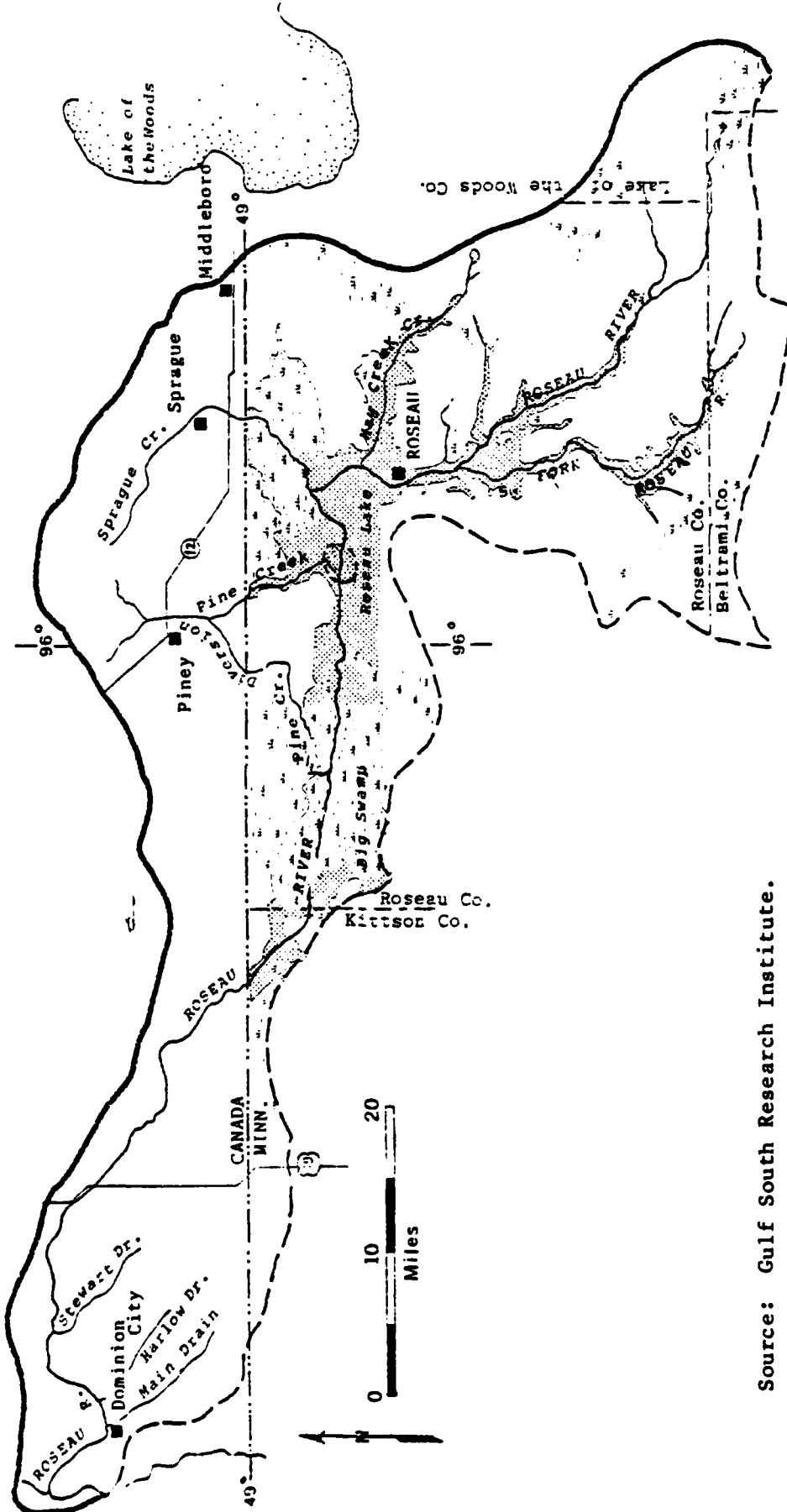
The topography of the subbasin, and particularly that of the United States portion, strongly influences flooding problems. Two physical features, Roseau Lake and Big Swamp, are noteworthy. The former, a shallow, permanent water body in its natural state, is now drained by lateral ditches and channel improvements and holds water only during flood periods. Big Swamp begins about 10 miles west of Roseau Lake and occupies the major portion of the subbasin. During high-flow periods, part of the flow that overtops the south banks within the Big Swamp finds its way overland and through ditches into several branches of Two Rivers.

The tributary area above Roseau Lake contains notably steeper slopes than the remainder of the subbasin. The general flatness of the topography is accentuated by the fact that approximately half of the area within the United States portion of the subbasin is under cultivation. The remainder is either swampland or state-owned wildlife habitat.

Location and Extent

Figure II depicts the 100-year floodplain for the United States portion of the subbasin. Prior to this study, no attempt had been made to publish even a generalized delineation. A number of sources were investigated in order to produce the present delineation. Among these were: (1) U.S. Geological Survey (USGS) Flood Prone Area Maps at 1:24,000 scale; (2) Federal Insurance Administration flood maps (various scales); (3) published secondary sources describing flooded areas; and (4) USGS 7 1/2 minute topographic maps.

The map is thus a composite of available sources supplemented by inferences where necessary. Because the sources were incomplete and based on surveys differing in purpose and accuracy, it should be understood that Figure II constitutes a generalized delineation intended only for planning purposes. A more complete description of sources and limitations is given in Appendix A.



Source: Gulf South Research Institute.

Figure II. 100-YEAR FLOOD PLAIN

According to this initial delineation, the U.S. portion of the Roseau River floodplain comprises approximately 170,000 acres. Some 72,000 acres of this amount is wetlands. Another 114,000 acres of wetlands not identified with the 100-year flood level is also indicated. Major floodplain components by tributary and segment include: the South Fork of the Roseau--12,000 acres; Hay Creek--10,000 acres; Roseau River headwaters to the city of Roseau--12,000 acres; and Roseau River from Roseau to the Canadian border--136,000 acres.

The U.S. portion of the subbasin lies almost entirely in the gently rolling uplands. The South Fork of the Roseau extends from the northwest corner of Beltrami County to its confluence with the Roseau some four miles above the city of the same name and is approximately one-half mile in width. Altogether, this accounts for 24,000 acres centered on a broad area south of the town of Malung. The floodplain measures some three miles in width (Figure II) at this point.

The Hay Creek floodplain branches eastward from that of the Roseau several miles northeast of the city of Roseau. The portion north of State Highway 11 is 1½ to 2½ miles in width, but the remainder narrows to an average of one mile or less. Some 2,000 acres of wetland north of Highway 11 are included in the 10,000-acre total for this tributary area.

The floodplain of the Roseau River north of the city of Roseau offers a strong contrast to the other segments discussed in that it is characterized by extensive wetland and non-wetland areas. The former accounts for some 70,000 acres of the 136,000-acre total. The principal portion averages five miles in width and extends westward 30 miles (Figure II). The delineation, based primarily on flood insurance maps, is in general agreement with descriptions and acreage estimates in descriptive sources.

Flood Damages

The primary areas affected by flooding throughout the subbasin's floodplain are agricultural, and environmental in nature and to a lesser extent, urban. Roseau is the only urban area in the subbasin that is subject to flooding. The only damage categories taken into account in the computation of average annual damages are urban and rural.

Present average annual damages in the subbasin are estimated at \$2.7 million. This is quite a sizable figure, accounting for eight percent of the Red River of the North basinwide average annual flood damage total. Average annual damages are divided into two basic classifications: urban and rural. Urban damages include damages to residences, businesses (commercial and industrial), and public facilities (streets, utilities, sewers, etc.). Rural damages include damages to crops, other agricultural assets (fences, machinery, farm buildings, etc.) and transportation facilities. Rural damages account for 92 percent of the total average annual damages in the subbasin, and urban damages account for the remaining eight percent.

There were no urban damages reported for the subbasin as a result of the 1975 flood event. Average annual urban flood damages in the subbasin are estimated at \$217,400. Urban flood damages sustained during the 1979 flood event amounted to \$39,000. A more detailed breakdown of these urban flood damage figures appears in Table 1. Urban damages resulting from the 1979 flood event included \$19,500 in residential damages, \$15,600 in damages to businesses, and \$3,900 in public damages. Average annual urban flood damages included \$108,700 in residential damages, 87,000 in business damages, and 21,700 in public damages.

Table 1
ROSEAU RIVER SUBBASIN, ESTIMATED 1979 AND AVERAGE
ANNUAL URBAN FLOOD DAMAGES
(Thousands of 1979 Dollars)

Category	1979	Average Annual
Residential	\$19.5	\$108.7
Business	15.6	87.0
Public	3.9	21.7
Total	\$39.0	\$217.4

Sources: Red River of the North Basin Plan of Study, April, 1977; Post Flood Report 1979; and Gulf South Research Institute.

Average annual rural flood damages along with the rural flood damages sustained in the 1975 and 1979 flood events appear in Table 2. The 1975 flood event resulted in \$21.7 million in crop damages, \$11.4 million in other

Table 2
ROSEAU RIVER SUBBASIN, ESTIMATED 1975, 1979 AND
AVERAGE ANNUAL RURAL FLOOD DAMAGES
(Thousands of 1979 Dollars)

Category	Year		Average Annual
	1975	1979	
Crop	\$21,658.0	\$1,096.0	\$1,832.6
Other Agricultural	11,422.0	672.0	610.9
Transportation	347.6	250.0	39.1
TOTAL	\$33,427.6	\$2,018.0	\$2,482.6

Sources: Red River of the North Basin Plan of Study, April, 1977; Post Flood Reports 1975, 1979; and Gulf South Research Institute.

agricultural damages, and \$347,600 in transportation damages. Total rural flood damages sustained in the 1975 flood event were \$33.4 million.

The \$33.4 million figure for the 1975 flood event is 13 times greater than the average annual rural flood damage figure for the subbasin.

The 1979 flood event resulted in \$1.1 million in crop damages, \$672,000 in other agricultural damages, and \$250,000 in transportation damages.

Total rural flood damages from the 1979 flood event were \$2.0 million, slightly less than the average annual damage figure in the subbasin.

Average annual rural flood damages are estimated at \$1.8 million in crop damages, \$610,900 in other agricultural damages, and \$39,100 in transportation damages. Total average annual rural flood damages are \$2.5 million.

(It is noteworthy that a reanalysis of Roseau River Subbasin average annual damages has been completed. The estimates, prepared by the Economics Section of the St. Paul District appear as part of Appendix C to this report.)

Environmental Concerns

Numbers of large mammals and upland game birds have been reduced as the result of the elimination of forest and grassland cover. A total of 150,000 acres are considered to be excellent wildlife habitat in the subbasin, which need to be conserved and enhanced where possible. Data from the 1975 Minnesota Land Management Information Service indicate that more than half of the subbasin's total area is presently in cultivated

(37.9 percent), urban residential (0.1 percent), pasture and open (12.4 percent), urban non-residential (0.1 percent), and transportation (0.0 percent) uses. The most significant potential problem for waterfowl and semi-aquatic wildlife is the loss of wetlands (International Roseau River Engineering Board, 1975). Wetlands in the subbasin also need to be protected, conserved, and enhanced to the extent possible because of the many beneficial functions that they serve which will be discussed later.

Problems and needs related to aquatic life include the prevention of fish kills by excessive pollution from municipal, industrial, and agricultural waste discharges, and maintenance of productive habitats. The latter is concerned with the provision of adequate water depths during low flows, adequate water quality, and stream bottom conditions conducive for perpetuation of a normal food chain. Additionally, the low head dam at Roseau limits upstream migration of some fish species during flows other than high water (International Roseau River Engineering Board, 1975).

In addition to the problems described above, concern has been expressed over the Roseau River Flood Control Project. These concerns have been related to the effects of this project on the loss of aquatic and terrestrial habitats as a result of land use changes, loss of significant amounts and types of wetlands, increase in peak flood flows in neighboring Canada, reduction in populations of aquatic and terrestrial biota, degradation of high-quality game fishery habitat, etc. (U.S. Fish and Wildlife Service, 1977; Peterson and Enblom, 1978; International Roseau River Engineering Board, 1975; U.S. Army Corps of Engineers, 1976).

Recreational Problems

The major recreational problems in the subbasin relate to the lack of lakes in the Roseau River Subbasin. The development of Hayes Lake in 1973 has contributed substantially to the water-based recreational resources in the subbasin; however, sailing, boating, and water skiing opportunities are limited. The lake has been stocked with catfish, but the program's success remains uncertain.

Hunting opportunities are abundant in the subbasin because of the large areas of wildlife habitat. Continued drainage of wetlands for cultivation would seriously impair wildlife habitat and recreational activities. The resources of the subbasin are particularly valuable because they are scarce in the northern Minnesota portion of the Red River Basin. Frequent low flows and associated water quality problems in the Roseau River diminish its recreational and aesthetic potentials.

Water Quality Problems

According to the Upper Mississippi River Basin Commission (1977), the main water quality problem areas of the subbasin are: (1) insufficient flows, (2) municipal and agricultural water pollution, (3) limited water surface, and (4) high iron concentrations in the groundwater. The inadequate stream flows reduce the river's capacity for assimilating the municipal, industrial and agricultural effluents. This results in reduced recreation and environmental quality. The low flow also creates a low dissolved oxygen problem. Better treatment facilities for the identified point source problem areas need to be constructed. These areas will be discussed under Wastewater Management in this section of the report. Also, there is a definite need to acquire more information concerning the water quality of the river.

Water Supply Problems

There are few problems with water supply in the subbasin. The groundwater is suitable for domestic and stock use at most places, although the water is very hard (largely between 200 and 400 ppm up to a maximum hardness of 930 ppm). The iron content is high, and most well owners report "rusty water". Well drillers report a few areas where "dry holes" existed below the water table. Dry holes result when saturated materials lack sufficient permeability to yield water to wells. There has been no widespread decline in water levels in the subbasin. Groundwater is available over a large area, and yields are adequate for anticipated needs.

Erosion Problems

Soil erosion is not as prevalent a problem in the Roseau Subbasin as it is in the other subbasins because there are large areas of peat

and low gradient. Some sheet erosion occurs when water flows across plowed fields, causing loss of valuable topsoil. This may also result in increased maintenance costs for natural drainageways and drainage ditches. The land gradient (slope) is not high, so erosion from runoff is not a serious problem.

Irrigation

Irrigation practices in Minnesota have been increasing for forty years. Many farmers use irrigation to obtain a greater crop yield and to improve the quality of their crops.

In the subbasin, irrigation is not being practiced to a great extent. In 1975, no irrigated acreage was reported for the major portion (Roseau County) of the subbasin. A small amount of acreage (4,091 acres) in the western part of the subbasin (Marshall and Kittson counties) was being irrigated.

The region in which the subbasin is located is only moderately suitable for irrigation on the basis of soil composition. The potential for irrigation is unknown because there has not been an adequate investigation and documentation of the area's surficial sand aquifers.

Wastewater Management

Only two point sources were identified by the Minnesota Pollution Control Agency (1975) for the Roseau River. The existing treatment systems appear to be adequate in that no gross violations are consistently occurring. Table 3 lists the problems and needs of these two dischargers. In the early 1970's, Wannaska Creamery Association was considered to be in need of a new treatment facility. The facility was completed in 1975. The system at Roseau was adequately treating its wastewater.

A number of unsewered communities are located within the subbasin. It is assumed that no sewer and treatment systems will be required as long as individual septic tanks continue to be properly constructed and maintained (Minnesota Pollution Control Agency, 1975). The Upper Mississippi River Basin Commission (1977), on the other hand, reports inadequate treatment at the communities of Badger, Humboldt, and St. Vincent, which creates excessive coliform concentrations during low-flow periods.

Table 3
PROBLEMS AND NEEDS OF POINT SOURCE DISCHARGERS IN THE ROSEAU RIVER SUBBASIN

Receiving Water	Discharger	Problems	Treatment Needs	Other Planning Considerations
South Fork Roseau River	Wannaska Creamery Association	Nature of problems not known	Need a new treatment facility	Begin construction by 6-15-74
Hay Creek	Roseau	Treatment is adequate	Adequate treatment	be operational by 9-15-74 No future needs anticipated

Source: Minnesota Pollution Control Agency, 1975.

Hydropower

There are no hydroelectric facilities located in the subbasin, and the topography is too flat to warrant further development. Most of the future large-scale hydropower developments in Minnesota are expected to occur in the Minneapolis-St. Paul area, which is southeast of the Red River Basin.

Public Perception of Problems and Solutions

The public's perception of problems and solutions in the subbasin is adequately defined because the International Joint Commission and the Corps of Engineers have conducted numerous public meetings in connection with the Roseau River Flood Control Project and because the subbasin has been organized into a watershed district.

The primary documents for the identification of public perceptions are the multi-volume Joint Studies for Co-ordinated Water Use and Control in the Roseau River Basin, published in September 1975 by the International Roseau River Engineering Board (and subsequently in 1976 by the International Joint Commission) and the Final EIS for Flood Control on the Roseau River, published in December 1976.

During the course of the international investigation by the IJC, attitude surveys, public meetings, and information bulletins were used to effect communication between study personnel and subbasin residents. Separate attitude surveys conducted in the Manitoba and Minnesota portions of the subbasin in 1973 revealed that Manitoba respondents found the problem of draining floodwaters to be of greater urgency than spring flooding itself. With respect to the impact of the Corps proposed channelization project, there was found to be overwhelming support for flood control, particularly with regard to increased cultivated land in small farms.

In March 1974, four public meetings were held in Manitoba, during which many of the issues raised in the attitudinal survey were discussed. In February 1975, the Corps of Engineers met with officials of the Roseau River Watershed District and others in Minnesota to report on study progress and discuss project requirements. Public concern was expressed about

local effects of possible future drainage works in the Pine and Sprague creeks tributaries in Canada. Officials were also made aware of Canadian concerns about the possible raising of County Road 7 and the blocking of natural overflows into the Two Rivers Subbasin.

Following the distribution of the 1975 International Roseau River Engineering Board report, public hearings were held at Roseau and Dominion City on January 13 and 14, 1976. The IJC also accepted written submissions and correspondence, including statements made by elected officials, individuals, citizen groups, and municipal and watershed district representatives, and officials from Federal, state, provincial, and municipal agencies. Transcripts and written submissions are available for examination at the Commission offices in Ottawa and Washington, D.C. Transcripts of the 1976 hearings were also distributed to local libraries and municipal offices in the subbasin.

The essence and salient points of the testimony and written submissions are summarized in Chapter V of the 1976 IJC Report. Roseau witnesses generally spoke in favor of the proposed Corps of Engineers project, emphasizing the importance of drainage and flood control in Minnesota. Flood control was also stressed. Many farmers requested that existing drainage be maintained. Views on both sides of the issue of raising County Road 7 were expressed. Residents along the Red River objected to the Roseau River drainage project.

Additional evidence for interest in flood control measures is contained in public hearings held in East Grand Forks in 1978 and 1979 before subcommittees of the Committee on Public Works and Transportation of the U.S. House of Representatives. From these documents, it is evident that most residents of the Red River Basin consider flood control to be the primary water related need for the area and that they are interested in whatever solutions may be proposed by Federal, state, or local agencies.

IV. DESCRIPTION OF SUBBASIN RESOURCES

IV. DESCRIPTION OF SUBBASIN RESOURCES

This section of the report discusses the primary resource conditions within the United States portion of the subbasin that are water-related and that would be affected by a comprehensive water and related land resources plan centering on flood control measures.

Social Characteristics

Between 1930 and 1970, each of the five counties within the subbasin, except Beltrami, experienced a decline in population. During this same period, the state of Minnesota registered a significant increase in population. The major cause of the decrease in population was the outflux of people from the rural areas to more urban areas.

The number of farms in Roseau County decreased by more than 25 percent between 1959 and 1970. The consolidation of farms and the lack of industrial employment opportunities were responsible for the outmigration of about 20 percent of the people between 1960 and 1970. Between 1970 and 1977, however, farm consolidation decreased and employment opportunities increased, which caused a reversal of the outmigration rate.

During the 1970's, the subbasin's population increased 8.7 percent (from 7,158 to 7,779). Preliminary figures for 1978 indicate that the subbasin will continue to increase in population, primarily because of immigration. Increases in immigration are occurring in the rural sector, which accounts for 67 percent of the population.

The subbasin is a sparsely populated area with only a few small towns. The population density increased from 6.3 persons per square mile in 1970 to 6.9 persons per square mile in 1977. The largest town is Roseau, with a 1977 population of 2,496. This constituted a 2.2 percent decrease from 1970.

Communities in the subbasin are close-knit, as can be partially illustrated by the length of residence. Ninety-one percent of the population resides in Roseau County. Census data for 1970 indicate that 84.2 percent of Roseau County residents own their homes. Sixty-five percent occupied the same residence in 1965, and 84 percent lived within the same county. Almost 94 percent of the work force also lived in the county.

Most of the population is of Scandinavian background, with Norwegian elements concentrated in Marshall, Roseau, and Beltrami counties and persons of Swedish descent primarily in Kittson and Lake of the Woods counties. The minority population is too small to be identified.

Economic Characteristics

Employment

Thirty years ago, the subbasin's economy was based primarily on agriculture. In 1950, more than 63 percent of the employed persons in Roseau County worked in agriculture. By 1960, less than 50 percent of the labor force was in farming; and in 1970, the number engaged in agricultural employment had fallen to less than 25 percent.

Agriculture is still an important part of the subbasin's economy, but other employment sectors have increased in importance. Services and manufacturing employment each account for approximately 25 percent of the total employment. Total employment in the subbasin increased from 2,577 in 1970 to 3,189 in 1977, which was a 24 percent increase.

Unemployment in the subbasin averaged about 8 percent between 1970 and 1977. With the exception of Marshall County in 1960, each of the five counties within the subbasin experienced higher rates of unemployment than the state did between 1950 and 1970.

Income

Total personal income for the subbasin increased from \$32 million to \$54 million between 1969 and 1977 (as expressed in 1979 dollars). Farm income in Roseau County accounts for about 50 percent of the total personal income, and cash grain sales amount to more than one-half of the total farm income. Average per capita income during the same years increased from \$4,419 to \$6,892, which was more than 20 percent below the 1979 average income figure of \$8,314 for the state. Although there has been an upward trend in both total personal and per capita income, fluctuating farm prices are the primary determinants of income changes from year-to-year. Also, severe flooding can cause sharp declines in income, as in 1975.

Business and Industrial Activity

Agriculture

Although a relatively small portion (20 percent) of the population of the subbasin is actively engaged in farming, the economy is heavily dependent on agriculture. In general, small grains such as wheat, barley, oats, and flax are grown in the subbasin. Large acreages are devoted to hay, and some corn and potatoes are grown. Corn is usually cut before it matures and is fed to livestock. There is some dairying in the subbasin, and significant amounts of cattle and sheep are raised. In 1978, Roseau County was the leading producer among all counties in Minnesota in sheep and lambs, and it was sixth in the production of beef cows.

The major crops grown in the subbasin are identified in Table 4. Wheat is the leading crop, accounting for almost 40 percent of the harvested acreage, followed by hay, oats, and barley, which collectively account for 44 percent of the harvested acreage. There are also minor acreages of flax, sunflowers, rye, potatoes, and sugarbeets. In 1978, the counties of Kittson, Marshall, and Roseau were among the top ten counties in Minnesota in the production of wheat, oats, barley, potatoes, sugarbeets, and sunflowers.

Table 4
1978 CROP STATISTICS, ROSEAU RIVER SUBBASIN

Crop	Harvested Acres	Yield Per Acre	Total Production
Wheat	103,000	33.7 bushels	3,471,100
Hay	46,500	1.9 tons	88,350
Oats	41,200	55.3 bushels	2,278,360
Barley	31,700	46.9 bushels	1,486,730

Source: Gulf South Research Institute.

The western and north-central portions of the subbasin are the most productive areas for growing crops. Livestock production is prevalent throughout Roseau County, which constitutes the central portion of the subbasin. Cropping patterns within the floodplain are similar to those mentioned for the subbasin as a whole. Small grains and hay

are important floodplain crops, and sugarbeets, potatoes, and sunflowers have grown in importance in the western part of the subbasin.

Manufacturing

There are six manufacturing establishments located in the town of Roseau. The two major types of products manufactured in the subbasin are wood products and recreational vehicles. Manufacturing has emerged as a very significant factor in the economy of Roseau County. Between 1958 and 1972, the number of people employed by manufacturers in Roseau County increased from 307 to 1,500, an increase of more than 800 percent.

Within the subbasin, the major manufacturer is the Polaris Division of Textron, Incorporated, which is located in the town of Roseau and manufactures snowmobiles, snowmobile trailers, and small utility vehicles. The rest of the manufacturing establishments employ a small number of people. The types of establishments and number of employees in the subbasin are identified in Table 5.

Table 5
MANUFACTURING ESTABLISHMENTS, ROSEAU RIVER SUBBASIN

SIC	Description	Estimated Employees
20	Food and Kindred Products	20
24	Lumber and Wood Products	8
27	Printing and Publishing	8
28	Chemicals and Allied Products	8
35	Machinery, except Electrical	8
37	Transportation Equipment	600
TOTAL		652

Source: 1979-80 Minnesota Directory of Manufacturers.

Trade

In 1977, total trade receipts for the subbasin exceeded \$53 million (expressed in 1979 dollars). Nearly 55 percent (or \$28.9 million) of the receipts were wholesale trade. Retail trade and selected service receipts were \$24.3 million and \$3.5 million, respectively, in 1977.

Transportation Network

The subbasin is one of the least populated areas in the entire Red River Basin. The city of Roseau is the transportation center of the subbasin, since it is situated at the junction of State Highways 11 and 89. State Highway 11 provides access to Federal Highways 59 and 75 west of the subbasin. These highways intersect Interstate 94 to the south, which travels to Fargo-Moorhead and Minneapolis-St. Paul. Highway 59 also intersects Federal Highway 2, which travels to the port of Duluth. The city of Roseau is on the Burlington Northern Railway, which provides freight service every other day. Roseau also has a secondary airport, which offers charter air service. No pipelines cross the subbasin.

Land Use

Approximately 37.9 percent of the subbasin is under cultivation, 30.2 percent is forest, 19.2 percent is water and marsh, and 12.4 percent is pasture. The water and marsh areas are located primarily in the northern part of the subbasin, and there are some small areas in the southeastern part. The largest concentrations of forest are also in the southeastern part, but there are forested areas near the Canadian border and along stream banks. Cultivated land and pasture are common throughout the subbasin, except in the southeastern part.

Land use in the floodplain of the Roseau River does not differ significantly from land use in the subbasin. The floodplain is an important agricultural area, and there are significant forest acreages along the river in the southeastern and northern parts of the subbasin.

Environmental Characteristics

Climate

Climatological data can be obtained from the U.S. Weather Bureau Station at Roseau.

The climate of the subbasin is characterized by wide temperature variations, moderate to heavy snowfall, and summer rainfall generally ample for crop growth. Average annual temperature in the subbasin is about 37° F, with extremes from a high of 107° F to a low of -52° F. The frost-free period extends from about May 20 through the end of August.

and averages 102 days. Annual precipitation averages 20 inches, 70 percent of which normally occurs during the frost-free period. Rainfall in the area is heaviest during June and July. Poor drainage and low gradients create a natural environment leading to high evapotranspiration losses. Annual actual evapotranspiration at Roseau equals approximately the annual precipitation during years of normal precipitation. Snowfall averages about 35 inches annually. Storms affecting the Roseau subbasin generally travel southeast and occur both as snow and rain. Winter snowstorms are frequently accompanied by high winds that create blizzard conditions.

Geology

The subbasin lies within the Western Lake Section in the Central Lowland Province of the Interior Plains. Bedrock in the northern section is predominantly undifferentiated Precambrian igneous and metamorphic rock overlain by Ordovician limestone and dolomite and a small section of Cretaceous deposits. The southern portion of the area consists of a small area of Precambrian sediment overlain by undifferentiated Cretaceous sandstone and interbedded shale.

Surficial characteristics are the result of glaciation during the Pleistocene. The retreat of glaciers left behind a mantle of glacial till and outwash deposits. Lake Agassiz was formed during the retreat of the last glacier. Silts and clays from the deeper parts of former Lake Aggasiz are present in the western Canadian portion of the subbasin. Former lake shorelines, marked by sand and gravel ridges, are evident in the western portion of the subbasin in the United States. The Beltrami Island Uplands in the southeastern portion of the subbasin form a prominent outwash area consisting of sand and gravel interspersed with large areas of till. Peat bogs are common surface expressions of high water table areas such as Big Swamp between Caribou and Duxby. In localized areas, peat bogs may be as much as 20 feet thick.

Biology

The major forest types occurring in the subbasin consist of elm-ash-cottonwood, aspen-birch, spruce-fir, pine, and unproductive forest land. The elm-ash-cottonwood type is found between Caribou and Ross

and east of Pine Creek, generally away from the Roseau River. This community reaches its best development in the floodplains of both the Roseau and South Fork Roseau River south of Malung in the headwaters region. The aspen-birch type is most abundant in the vicinity of Caribou near the Canadian border and in the headwaters area. The spruce-fir type is situated west and east of Pine Creek along the Minnesota-Canada border and in the headwaters of the Roseau River north and northeast of Skinner. The pine type is also found in the headwaters northeast of Skinner, as is most of the unproductive forest land or poorly-drained areas with swamp conifers. These lowland conifers are also scattered within the spruce-fir type around Pine Creek (North Central Forest Experiment Station and Minnesota State Planning Agency, no date).

Some vegetation studies have been conducted within the subbasin in association with the U.S. Army Corps of Engineers' Roseau River Flood Control Project. Peterson and Enblom (1978), in a preliminary report subject to revision, investigated the area between Malung and the Canadian border along the river. It was found that much of the area was used for agricultural purposes (cropland and pasture). A narrow corridor of woodlands, sometimes only 50-100 feet wide, occurred along most of the river. Typical tree species included black and green ash, boxelder, basswood, elm, and bur oak. Red-osier dogwood was the principal shrub species, and the poorly developed herbaceous layer was composed of ferns, nettles, horsetail, goldenrod, smartweed, fleabane, and asparagus.

The International Roseau River Engineering Board (1975) described the results of a study conducted by the University of North Dakota Institute for Ecological Studies entitled "Environmental Impact Assessment of the Roseau River, Minnesota, Flood Control Project." Eight community types were reported:

1. Black ash-basswood community--generally occurs from Roseau north to the Old Roseau Lake region within the floodplain. Apart from the trees, dominant plants are wood nettle, bloodroot, St. John's wort, thimbleweed, and nodding trillium.
2. Aspen-balsam-poplar community--common throughout the Roseau River Basin. Typical shrubs include American hazlenut, beaked hazlenut, nannyberry, downy arrowwood, and highbush cranberry. Principal herbs are red baneberry, wild rye, and vetchling.

3. Bur oak-green ash community--found on high ground along the river between old Roseau Lake area and Roseau River channel cutoffs west of Duxby. Characteristic plants are hawthorne, stinging nettle, and thimbleweed.
4. Green ash-elm community--Common on old spoils of channels and along river banks for region described for bur oak-green ash community. Grasses consist of reed canary-grass, Kentucky bluegrass, and sedges.
5. Jack pine community--found in Roseau River WMA, constituting the northern and western most stand of jack pine in Roseau County. Characteristic vegetation includes jack pine, common bearberry, strawberry, and low sweet blueberry.
6. Tamarack community--occurs in northern peatlands of Roseau County. Common plants are common burdock, marsh marigold, leatherleaf, dwarf corne, bedstraw, labrador tea, pitcher plant, and sphagnum mosses.
7. Altered fen community--common in western part of subbasin, particularly in Big Swamp area. Characteristic species are marsh bluebell, silverweed, hard-stem bulrush, and cattail.
8. Grassland community--common in the western part of Roseau County. Typical plants include smooth homegrass, timothy, goldenrod, and fringed gentian.

The subbasin is located within the Glacial Lake Agassiz Lowlands and Aspen Parklands wetland zones, as defined by Mann (1979). The Glacial Lowlands zone is typified by extensive peatlands, some having tree covered, raised bogs and sedge mats and aquatic emergents. The Aspen Parklands zone forms the dynamic transitional area between grassland and coniferous formations and is comprised of potholes and shallow marshes interspersed with aspen groves. Significant wetlands within the subbasin include Big Swamp, Pine Creek Watershed, Sprague Creek Watershed, Hay Creek Watershed, and other areas. Big Swamp is a large, flat peaty area composed of extensive sedge, cattail, willow, and alder swamps traversed by many old silt-filled drainage ditches. The Pine Creek wetland consists of tamarck peatlands and other wetlands. Sprague Creek and Hay Creek are similar. Wetland types found in these important areas, as well as in other parts of the subbasin include Types 3-6 and Type 8 (U.S. Fish and Wildlife Service, 1977).

Important wildlife habitats in the subbasin are the remaining grasslands, woodlands, and wetlands. The prairie remnants are valuable habitats for those species that utilize grassland ecosystems wholly or in part. The woodlands and brushy areas are significant as breeding, nesting, feeding, and resting areas for both migratory and resident wildlife. Where they are contiguous in a linear fashion along streams, they provide a travel corridor through disturbed (e.g. cropland) areas. The forested areas afford habitats for a greater variety of wildlife than any other major habitat type in the subbasin. Wetlands, including potholes, marshes, and open waterbodies, provide excellent habitats for aquatic and terrestrial biota. Organisms utilizing these areas include fishes, various aquatic invertebrates, waterfowl, big and small game, furbearers, some rodents, wading birds, and many species of songbirds (U. S. Fish and Wildlife Service, 1980).

The U.S. Fish and Wildlife Service (1977) stated that exceptionally high quality habitats and wildlife populations are present in the subbasin. They are valuable because they are "a vestige or remnant of original conditions once widespread across northwestern Minnesota and Southern Manitoba." Many species of fish and wildlife are considered significant on an international, national, and regional scale.

The white-tailed deer is the most abundant big-game animal in the subbasin. In the 1978 season, the following figures represent the combined firearm and archery harvest for the three counties included by the subbasin's limits: Kittson--722; Roseau--1,093; and Beltrami--1,794. Along the Roseau River, deer populations have been estimated at 20/square mile, and moose at 1-2/square mile. These are some of the highest densities in the state. Black bear occasionally occur in the more heavily wooded areas; 1978 harvest data indicated that eight were taken from Roseau County and 22 from Beltrami.

Small-game mammals and upland game birds of the region include the jackrabbit, Hungarian partridge (<5-20/100 miles), ruffed grouse, woodcocks, and sharp-tailed grouse (1-6 adult males/square mile). The major furbearing species are the mink, beaver, muskrat, red fox, and coyote. The raccoon, weasel, lynx, and bobcat are also harvested in smaller numbers. Some

timber wolves were represented in the catch prior to their listing as a Federally protected species (U.S. Army Corps of Engineers, 1975; U.S. Fish and Wildlife Service, 1980; International Roseau River Engineering Board, 1975).

Waterfowl production is significant in the wetlands of the subbasin in areas such as Big Swamp and around Pine Creek. The Roseau River Waterfowl Management Area (WMA) produces about 10,000 ducks and 300 Canada geese. Woodcocks and common snipe production are also important, and uncommon wildlife such as the Canada warbler, Connecticut warbler, and brown-capped chickadee, which are boreal birds, utilize the area. The subbasin lies mainly within the Minnesota Department of Natural Resources Region 1N, which has had a total of 101 species of breeding birds reported. These include: non-native pest birds--three species; non-native game birds--one species; native game birds--10 species; and native nongame birds--87 species. Common nongame birds in the subbasin include yellow warbler, veery, Baltimore oriole, and warbling vireo (U.S. Fish and Wildlife Service, 1977; International Roseau River Engineering Board, 1975; Henderson, 1978). In the University of North Dakota Institute for Ecological Studies report previously mentioned, a total of 162 bird species were recorded along the Roseau River; it was believed that 62 avian species were breeding during a censusing survey in this study. Peterson and Enblom (1978) reported 57 species along the river, including 12 species of waterfowl, seven species of raptors and shorebirds, and 19 species of perching birds.

Thirty-three species of nongame mammals have been identified from the counties included by the subbasin--Kittson, Roseau, Lake of the Woods, and Beltrami. In the University of North Dakota Institute for Ecological Studies investigation, eight species of small mammals were trapped from the major habitats/forest communities previously described. It was found that the Bur Oak-Green Ash and Green Ash-Elm communities had the greatest diversity and density of animals. Common nongame mammals in the project area include Gapper's red-backed vole, meadow jumping mouse, masked shrews, meadow vole, eastern chipmunks, and striped skunk (Henderson and Reitter, 1979; International Roseau River Engineering Board, 1975; U.S. Army Corps of Engineers, 1976).

Approximately 17 species or subspecies of amphibians and reptiles have been reported from the counties encompassed by the subbasin. Typical herpetofauna include the western plains garter snake, eastern tiger salamander, and northern leopard frog (Henderson, 1979).

The Roseau River has been designated by the Minnesota Department of Natural Resources as a warm water game fish (Class II) stream, which means that it is a small permanent stream that is too warm for trout but has a substantial population of forage and game fishes (U.S. Fish and Wildlife Service, 1979). The Department of Natural Resources has also stated that the Roseau River has "one of the best game fish populations of all warm water streams in Minnesota" (U.S. Fish and Wildlife Service, 1977).

The Corps of Engineers (1978) conducted an investigation of the fish populations in the Roseau River and found that walleyes and northern pike were the most abundant game species and that white suckers were the most abundant rough fish. During the summer of 1970, an accidental pesticide spill occurred on the Roseau River just below the town of Roseau. Five thousand fish were killed as a result of the spill. Ninety percent of these were northern pike, and the remaining 10 percent were walleye, suckers, and other species (U.S. Fish and Wildlife Service, 1977). The northern pike is so abundant in the Roseau River that several thousand fingerlings are captured each year for stocking in other streams. Sauger and rock bass are other commonly found game fishes. Rough and forage fish that frequently occur along the Roseau River include silver red horse, chestnut lamprey, common shiner, sand shiner, Johnny Darter, burbot, stone cat, carp, and fathead minnow (U.S. Fish and Wildlife Service, 1979; Marsh and Adelman, 1978). Only one trout stream, Bemis Hill Creek (Roseau County), is located in the subbasin. The Hayes Lake impoundment has been stocked with catfish fingerlings on an experimental basis since its inclosure in 1973, but the ability to maintain this fishery resource is uncertain (U.S. Army, Corps of Engineers, 1976).

Mayflies, caddisflies, beetles, and fly larvae are insects considered intermediate to common in the invertebrate community whereas stoneflies and alderflies are considered to have a rare occurrence along the Roseau

River. Snails and true worms (Oligochaetes) are also common. Clams and crustaceans (mostly crayfish) are in an intermediate abundance class. Daphnia, voluox, mougeotia, and spirogyra are common representatives of the microscopic plankton communities (U.S. Army Corps of Engineers, 1976).

Aquatic vascular plants are important to the river's ecosystem for numerous reasons such as production of oxygen, food, cover, and place of attachment for periphytic organisms. Emergent plants of the subbasin are located primarily near the Oxbow Lakes and along the point bars of the river. Rushes (Eleocharis spp.), arrowheads, cattails, water smartweed, sedges (Carex spp.), and bulrushes are abundant emergent species. Giant burweed, sweetflag, and water plantain are emergent species found in the Oxbow Lakes but not along the river channel. Submerged plants are fairly abundant throughout the river basin, except in scattered reaches where there is no favorable substrate for vegetative growth. Common submergent species include Canada waterweed, wild celery, coontail, bladderwort, and lesser duckweed. Additionally, within the Oxbow Lakes, common submerged vegetation include water milfoil, marestail, and sago pondweed.

The game and fish lake resources are listed, by lake type, in Table 6. Roseau County comprises most of the subbasin's drainage area within the United States. Only small portions of Kittson, Beltrami, and Lake of the Woods counties are in the subbasin.

Water Supply

Surface water is not used for municipal purposes in the U.S. portion of the subbasin, and only a small amount is used for watering stock. Moderate supplies of groundwater for domestic and small industrial and community supplies are available at most places in the subbasin.

Groundwater development is confined largely to a 470 square mile agricultural area around Roseau and provides water for domestic and stock usage. Roseau, which is the largest city in the subbasin, obtains its water supply from three municipal wells and has one standby well. All four wells are approximately 150 feet deep. The most current figures (1978-1979) from the Minnesota Department of Health show Roseau's annual water consumption to be approximately 127,750,000 gallons.

Table 6
FISH AND GAME LAKE RESOURCES, BY LAKE TYPE, IN THREE*
OF THE FOUR COUNTIES INCLUDED IN THE ROSEAU RIVER SUBBASIN

Type	County							
	Kittson		Beltrami		Lake of the Woods			
	Number	Acres		Number	Acres		Number	Acres
Dry Lake Basins ¹	-0-	-0-		1	90		-0-	-0-
Game Lakes ²	3	494		64	5,660		1	182
Marginal Lakes ³	-0-	-0-		25	4,373		-0-	-0-
Fish and Game Lakes ⁴	-0-	-0-		-0-	0-		-0-	-0-
Fish Lakes ⁵	1	--		103	--		1	--
Unclassified Lakes ⁶	-0-	-0-		40	5,086		-0-	-0-
Centrarchid Lakes ⁷	-0-	-0-		32	6,837		-0-	-0-
Walleye Lakes ⁸	1	313		17	349,460		1	407,360
Trout Lakes ⁹	-0-	-0-		2	48		-0-	-0-

* Roseau County has no significant lakes.

¹Dry lakes as reported here include those basins that do not have standing water throughout the year. This includes drained lake basins, dry basins with emergent vegetation such as cattails, and shrub swamps.

²Game lakes are those lakes shallower than six feet which ordinarily contain water throughout the years. They are ordinarily designated as being Type III or Type IV marshes.

³Marginal lakes are those that range from six to 20 feet deep, winterkill, and frequently have rough fish populations. Lakes with inlets are most likely to have rough fish populations.

⁴Fish and game lakes are defined as lakes in which both the game and fish resources are of major importance. These are lakes with several distinct connected basins, some river lakes, impoundments (especially the navigation pools on the Mississippi River), and the northern pike--wild rice--waterfowl lakes.

⁵Fish lakes are those that do not winterkill and have maximum depths that are ordinarily more than 20 feet and average depths that are 10 feet or more. Some soft water lakes, however, have average depths less than 10 feet and do not winterkill, and some fertile shallow lakes have inflows of water that add sufficient oxygen to prevent winterkill.

⁶Unclassified fish lakes are those where sufficient information is available to determine that they do not winterkill and are definitely fish lakes, but data available does not justify further classification. This category also includes a few lakes that do not readily fall into the remaining categories. For example, rough fish lakes that do not winterkill.

⁷Centrarchid lakes are those having fish populations that are primarily composed of bluegills, pumpkinseed, crappies, rock bass, largemouth bass, and/or smallmouth bass. These lakes frequently have good populations of northern pike. Some of these lakes contain populations of walleye that are either artificially maintained or are a natural population that is a small fraction of the total fish population. In the northeastern part of the state smallmouth bass and rock bass tend to be the most important segments of a centrarchid population in a lake. Crappies and green sunfish are the centrarchids that occur most commonly in very eutrophic southern lakes.

⁸Walleye lakes are those having walleyes, yellow perch, common suckers, northern pike, and frequently tullibee as the main constituents of the fish population. Sometimes these lakes have fair sized populations of centrarchids, but they tend to be restricted to protected areas such as shallower weedy bays.

⁹Trout lakes are those containing known populations of trout, either naturally or maintained by stocking.

Source: Peterson (1971).

Most wells in the subbasin must be drilled through hard pan clay and gravel. Beginning in the southeast section below Roseau and travelling in a northwesterly direction, natural artesian flows are frequently used by farmers in the rural areas.

Water Quality

Although the water quality of the Roseau River is good, the Minnesota Pollution Control Agency (1975) classified the U.S. Reach as Water Quality Limited. This evaluation means that the river does not meet applicable water standards and/or is not expected to meet these standards even though secondary treatment for municipalities, or best practicable treatment for industrial effluent, may be applied. This rating was given to the Roseau River for two reasons: (1) periodically the stream flows are not sufficient to provide enough dilution to maintain water quality standards after introduction of secondarily (or best practicably) treated effluents, and (2) nonpoint sources are expected to cause violations or water quality standards (Minnesota Pollution Control Agency, 1975).

Table 7 presents water quality data for the Roseau River near Malung. Only eight samples were taken at this recording station, and these were collected during 1967 and 1968. The water quality of the river at this recording station was very good. The only parameter that was in violation of the standards was turbidity (25 percent of the samples), which could have occurred naturally or could have been the result of either point or nonpoint sources.

Table 8 presents the water quality data of two points along the Roseau River from November, 1977 to August, 1978. In slight contrast to Table 7, this data shows that there are other violations of standards. The concentration of ammonia at the Caribou Station was generally (75 percent of the time) in violation of the standard. Most of the time iron concentrations were well below the standard, with the one exception at Caribou. Similarly, fecal coliform counts were normally well within the acceptable limits. The low dissolved oxygen occurred during February and March, as a result of low flows and ice and snow. The condition will probably continue to occur; however, with improved treatment facilities, all other parameters

14

SURFACE WATER QUALITY
NEAR MALUNG¹

Description	Flow (cfs)	Temperature (°F)	D.O. (mg/l)	BOD ₅ (mg/l)	NR3 (pp/l)	Fecal Coliforms (MPN/100 ml)
Water Quality Standards in this Segment		Maximum 86° Maximum change 5	6-4/1-5/31 5- other times	---	1.0	200
	Average	Average	Average	Average	Average	Average
Monitoring Stations	7-Day 10-Year Low	Maximum	Percent of Violation	Minimum Percent of Violation	Maximum Percent of Violation	Percent of Violation
RDS-21 Bridge CRAB-2 at Malung 8 reports 1967-68	<1	52	0	---	2.6	0.10
		76		---	4.5	0
					0.32	31
					80	0

Source: Minnesota Pollution Control Agency, 1975.

Table 7

WATER QUALITY DATA FOR THE ROSEAU RIVER
BALUNG FROM 1967-1968

Flow (ml)	TDS (mg/l)	pH	Turbidity (JTU)	Oil (mg/l)	NO ₂ (mg/l)	Phosphorus (mg/l)	TSS (mg/l)
	700	6.5-9.0	25	0.5	--	--	--
Average	Average	Average	Average	Average	Average	Average	Average
Percent of Violation	Percent of Violation	Percent of Violation					
Maximum	Percent of Violation	Range	Maximum	Maximum	Percent of Violation	Maximum	Percent of Violation
287	0	7.7 7.2- 8.2	21	25	--	0.40	0.08
0	--	0	50	--	--	0.64	0.16
							72

Table 8
SURFACE WATER QUALITY FOR THE ROSEAU RIVER NEAR ROSEAU AND CARIBOU,
NOVEMBER 1977 TO AUGUST 1978

Parameter	State Criteria ¹	EPA Freshwater Criteria ²	Maximum		Minimum	
			Roseau	Caribou	Roseau	Caribou
Flow (cfs)	--	--	1,210.0	2,120.0	6.0	5.8
pH (Standard Units)	6.5-9.0	6.5-9.0	8.2	8.5	7.4	7.2
Temperature (°C)	30°C max.	--	24.5	24.0	-0.5	-0.5
Turbidity (JTU)	25	--	15.0	4	2.5	4
D.O. (mg/l)	5.0 mg/l min.	5.0 mg/l min.	11.7	10.4	3.6	0.3
Fecal Coliform (#/100 ml)	200/100 ml	--	200.0	120.0	19.0	8.0
Dissolved Solids (mg/l)	700 mg/l	--	133.0	415.0	18.0	118.0
Total Nitrogen (mg/l, N)	--	--	1.2	1.3	0.61	0.86
Total Phosphorus (mg/l, P)	--	--	0.09	0.16	0.03	0.02
Ammonia (mg/l, N)	1 mg/l	--	1.1	1.3	0.35	0.75
Iron (µg/l)	--	1000 µg/l	710.0	2,400.0	250.0	200
Arenic (µg/l)	--	100 µg/l	--	2	--	1
Cadmium (µg/l)	--	12.0 µg/l	--	10	--	1
Chromium (µg/l)	50 g/l	100 µg/l	--	10	--	4
Mercury (µg/l)	--	0.05 µg/l	--	<0.5	--	0.0
Copper (µg/l)	10 µg/l	--	--	<10.0	--	2.0

¹ From Minnesota Pollution Control Agency, 1975.

² From U.S. Environmental Protection Agency, 1976

Source: Minnesota Pollution Control Agency, 1975.

should be within the allowable limits. Surface water and bottom sediment analyses for pesticides were performed during this same period near Caribou. Some of the major pesticides tested included aldrin; DDT; diazon; endrin; heptachlor; methoxychlor; lindane; toxaphene; 2, 4-D; and 2, 4, 5-T. None of the pesticides tested had detectable levels in either the surface water or sediment samples.

The groundwater in the subbasin is normally suitable for domestic and stock use, although the water is very hard. Hardness usually ranges between 200 to 400 ppm, but occasionally these concentrations occur at maximums up to 930 ppm. Dissolved solids range largely between 200 and 500 ppm, but are sometimes as high as 1,800 ppm. Iron is also very high (maximum of 4.1 ppm), and residents frequently report "rusty" water. Table 9 lists water quality data from six different wells located within Roseau County.

Aesthetics

The subbasin is predominantly agricultural, but there are several areas of aesthetic appeal. The major aesthetic resources of the subbasin include a portion of Beltrami Island State Forest and Hayes Lake State Park. Beltrami Island State Forest, comprising 505,954 acres, is partially located in the extreme eastern portion of the subbasin and provides a large forested area with associated aesthetic opportunities. Hayes Lake State Park (29,600 acres) is located 22 miles southeast of Roseau. The park provides a variety of water-based and water related recreational activities, including swimming, camping, and picnicking and is located in a wooded area bordering the prairie that provides ideal terrain for hiking and snowmobile trails.

Cultural Elements

Glacial Lake Agassiz prohibited continual prehistoric occupation of the subbasin until sometime after 9000 B.C. As in other parts of the Red River Valley, the beach ridges (strandlines) of Glacial Lake Agassiz have played significant roles in the prehistoric settlement patterns of the Roseau River region (Johnson, 1962:126; Saylor, 1975:251). The earliest documented archeological remains from the subbasin are associated with archaic hunter-gatherers who occupied the area until approximately 1000 B.C. (see Brew and Yourd, 1977; Johnson, 1975). For example,

Table 9
GROUNDWATER QUALITY FOR SIX WELLS IN ROSEAU COUNTY

Well Number	1	2	3	4	5	6
Depth in feet	114	120	135	140	180	230
Suspended matter	-	-	-	246	-	-
Total Fe	0.6	0.2	tr*	1.9	tr	4.6
SiO ₂	12.0	15.0	13.0	11.0	9.0	12.0
Fe	0.6	0.2	tr	1.9	tr	4.6
Al	0.9	0.3	2.1	tr	2.1	-
Ca	60.0	50.0	70.0	24.0	27.0	23.0
Mg	38.0	20.0	60.0	23.0	27.0	14.0
Na	60.0	33.0	75.0	123.0	97.0	99.0
K	10.0	9.0	12.0	14.0	25.0	8.0
CO ₃	-	2.4	tr	9.6	4.8	2.4
HCO ₃	464.0	298.0	451.0	310.0	307.0	288.0
SO ₄	23.0	4.0	168.0	118.0	104.0	47.0
Cl	5.3	3.5	10.0	10.0	18.0	25.0
NO ₃	-	tr	tr	tr	-	tr
H ₃ PO ₄	tr	3.9	tr	tr	1.4	2.8
Volatile and organic matter	96.0	60.0	80.0	112.0	86.0	56.0
Total dissolved solids	454.0	280.0	646.0	512.0	490.0	400.0
Total hardness (calculated)	305.8	207.0	421.0	154.3	178.2	114.9

Note: Unless otherwise noted, all units are in milligrams per liter (mg/l).

*tr = trace

1. Flowing well at Warroad School.
2. Well of Ed Grill in Roosevelt.
3. Badger creamery well.
4. Roseau creamery well.
5. Greenbush creamery well.
6. Well of Ebert Lundemo, SE $\frac{1}{4}$ Sec. 6, Nereson Twp. (T.160 N., R. 41 W.).

Source: International Roseau River Engineering Board, Appendix B, 1975.

12 of 16 recorded archeological sites are either aceramic or Archaic in cultural context. It has been suggested that kill, food processing, and habitation sites may well be located near the glacial beach ridges (St. Paul District Corps of Engineers, 1976:41). Other high probability areas for prehistoric habitation are along stream banks and lake shores. In fact, all of the recorded sites of the subbasin are located along the Roseau River. This apparent association of archeological resources with major streams could have significant impacts upon implementation of proposed flood control measures.

In addition to Archaic habitation sites, the Roseau River region is characterized by late Woodland cultures such as the Blackduck focus. With systematic investigation, the subbasin might provide valuable information on Archaic settlement in the Red River Valley as well as elucidate the diffusion of the Blackduck focus from northeastern Minnesota to southern Manitoba, Canada.

In late prehistoric times, the Cree, Assiniboine, and other Siouan tribes may have traversed the plains (and marshes) of the subbasin. The first white explorers in the area were French Canadians associated with the trader-explorer Pierre Gaultier de Varennes (Reid, et al., 1974:65). By the mid 19th century, the Hudson's Bay Company had expanded its fur trade to the Roseau River region and established a port in the vicinity of Roseau Lake (Reid, et al. 1974:65). Settlement of the subbasin was intensified during the late 1800's after Indian land cessions by the treaties of 1863 and 1889 (Blegen, 1963:172-173). There is a known and recorded Ojibwa cemetery at river station 1600+00. Systematic surveys throughout the subbasin should substantially improve the inventory of cultural resources.

Recreational Resources

Recreational resources within the subbasin are significant because a substantial portion of the land is publicly owned and managed as wildlife habitat for forestry and recreational purposes. A total of 123,281 acres are designated as recreational lands, excluding Beltrami Island State Forest. Most of these lands are in wildlife management areas. In addition

to these areas, the most important recreational resource is the Hayes Lake State Park. There are only two additional state parks in the Minnesota portion of the Red River Basin. The state park and other recreational areas over 15 acres in size are illustrated in Figure III. An inventory of facilities at these sites, which comprise 99 percent of the total recreational lands in the subbasin, is included in Appendix B of this report.

As is illustrated by the large number of acres included in the five wildlife management areas (93,261) and Beltrami Island State Forest (121,680 total acres), hunting is an important recreational activity in the subbasin. Game species include white-tailed deer, moose, bear, sharp-tailed and ruffed grouse, woodcock, rabbits and waterfowl. A report by the Institute for Ecological Studies in 1969 indicated that the Roseau River Wildlife Management Area is used 20,000 man-days by the public. Fishery resources in the subbasin are generally limited to the Roseau River downstream from the city of Roseau and the impoundments in the Roseau River Wildlife Management Area. Northern pike, walleye, and various other species of game and forage fish are present in these locations. Hayes Lake has been stocked with catfish.

Snowmobiling is a popular sport in the subbasin. The frozen waters of Roseau River and tributaries are in many ways ideal areas for this growing sport. There are over 1,000 acres of recreational sites in private or municipal parks, campgrounds, and school athletic fields providing subbasin residents with a variety of water-related and non-water-based recreational opportunities. No proposed recreational sites have been identified.

Significant Environmental Elements

Social

Roseau is the major population center of the subbasin and has recently experienced significant industrial growth. Most of the smaller towns are agricultural service centers. Flooding problems primarily affect Roseau, the town of Hallock, and the agricultural lands located in the valley. Damages as a result of flooding in the towns are related to the disruption of commercial activity, water supply and sewage problems, and increased maintenance cost to repair roads and bridges. Farmers in the

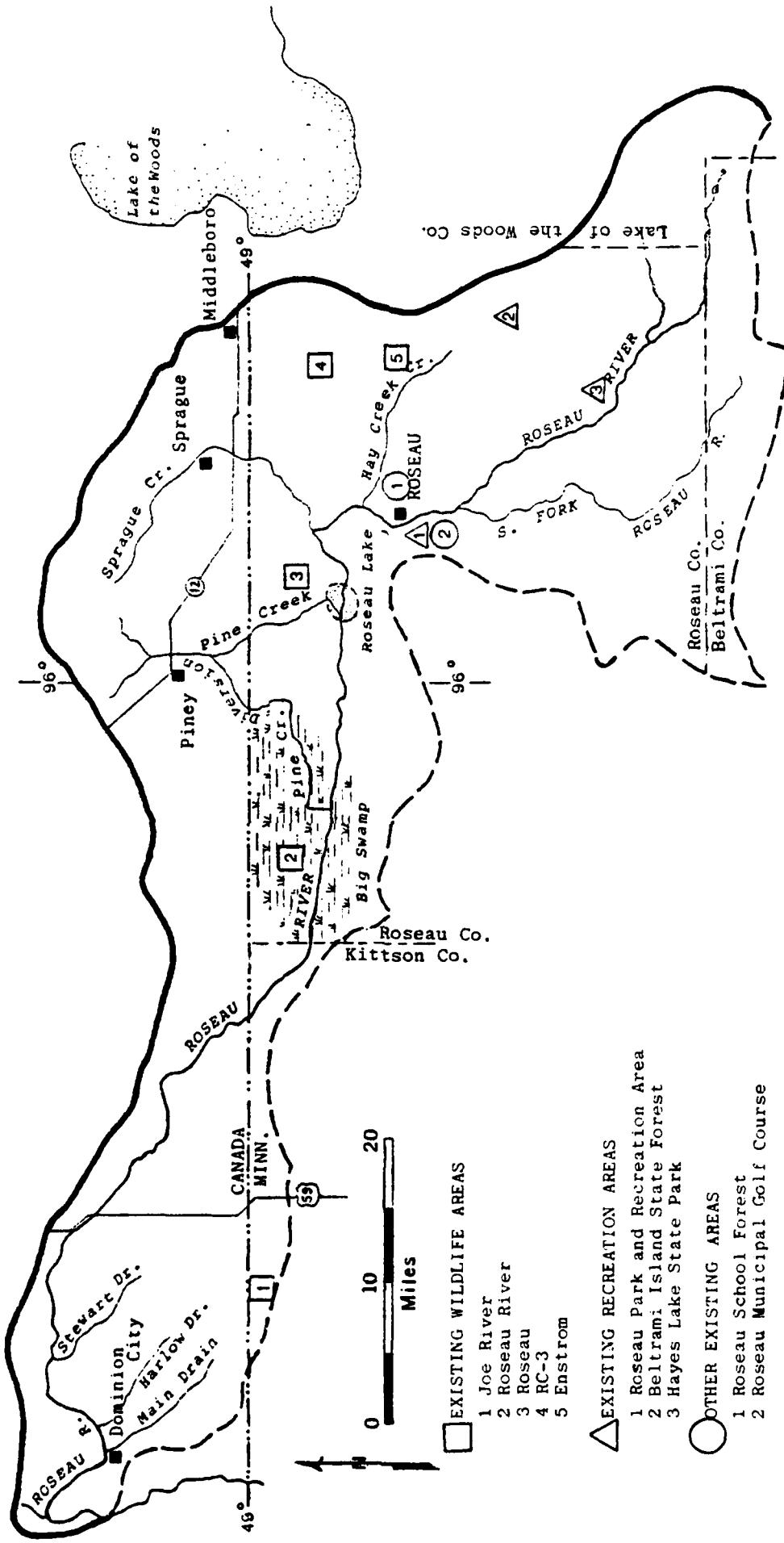


Figure III: RECREATIONAL RESOURCES

Source: Gulf South Research Institute.

area are affected by loss of valuable topsoil, damages to crops, farm equipment, and structures, and delays in planting. Agricultural service centers and the town of Roseau may experience secondary effects of flooding through economic losses in the agricultural sector.

Cultural

Sixteen archeological sites are recorded in the subbasin. Most of the inventoried archeological sites have woodland cultural components, but Archaic sites are also well represented. An Ojibwa cemetery at river station 1600+00 has been recorded. A more complete identification of potentially significant cultural resources is not possible at this time.

Soils

The entire subbasin lies within the plain of former Glacial Lake Agassiz. Thinly bedded silts and clays form the foundation for most of the soils. These relatively impermeable sediments have prevented water from infiltrating to lower levels. The resulting high water table has produced vast areas of peat and gleyed silts and clays.

Peat comprises the bulk of the surface soil in the northern portion of the subbasin, and any wet areas have been drained to create pasture. In the headwaters area, sand is the primary soil type north of the river and peat to the south. Sandy soils prevail next to the river north of the headwaters and adjacent to the river westward. Glacial till becomes the predominant soil type in the central region of the subbasin. Much of the peat land in the western section is unsuitable for agriculture because of the low river gradient.

Water

Except for the Roseau River and Hayes Lake, the subbasin does not have any large bodies of water. The water areas amount to only four percent of the total land area. Both lake and river are important for recreation and fish and wildlife.

Woodlands

The woodlands and brushy areas of the subbasin are important because of their value as habitats for wildlife. Additionally, they can be considered

significant because the subbasin has the second largest percentage of wooded acreage among the Minnesota subbasins of the Red River of the North Basin. Data from the Minnesota Land Management Information Service (MLMIS) show that 220,840 acres, or 30.2 percent, of the total subbasin area (730,200 acres) is forested, which is second only to the Red Lake River Subbasin. Because of their importance for wildlife and their relatively large area, the woodland habitats of the subbasin should be protected, conserved and enhanced whenever possible.

Table 10 shows a comparison of the percentage of woodland vegetation in each county of the subbasin between 1969 and 1977. Each county showed an increase during this eight-year period, which can probably be attributed to the following conditions: (1) plantings of windbreaks and shelterbelts by local landowners around homesteads and streams; and (2) reestablishment of vegetation in the lower reaches of stream floodplains in lands formerly cultivated (U.S. Fish and Wildlife Service, 1980).

Table 10
COMPARISON OF COUNTY PERCENTAGES OF WOODLAND
VEGETATION BETWEEN 1969 AND 1977

County	Percentage of County Containing Woodland Vegetation		Change in Percent Composition
	1969	1977	
Kittson	9.6	15.5	+5.9
Roseau	28.8	34.0	+5.4
Lake of the Woods	42.6	53.9	+11.3
Beltrami	48.4	62.4	+14.0

Source: Minnesota Land Management Information Service in U.S. Fish and Wildlife Service, 1980.

Wetlands

The wetlands of the subbasin are important because of their many beneficial functions and values such as waterfowl production areas, nutrient entrapment, floodwater retention, habitats for flora and fauna, and groundwater recharge (Cernohous, 1979; U.S. Fish and Wildlife Service, 1980; E.O. 11990, dated 24 May 1977). Although wetland inventory data from the 1964 and 1974 census were not collected for the counties of the subbasin, some information is available. Data supplied by the MLMIS indicate that 137,360 acres (or 18.8 percent) of the subbasin are marshlands.

As indicated earlier in the Problems and Needs section, drainage of wetlands is a major problem in the subbasin. Efforts are needed to conserve, protect, and enhance these sensitive and valuable habitats. Of particular importance are those areas described above as significant. These wetlands, and those on the Roseau River WMA, provide excellent habitats for game and nongame wildlife, rare or otherwise unique faunal species, and aquatic vertebrate and invertebrate populations.

Waterfowl Production Areas

Waterfowl Production Areas (WPAs) are wetland areas that the United States Fish and Wildlife Service has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting and feeding habitat for migratory waterfowl. There are no WPA's (fee and easement) presently located within the Roseau River Subbasin.

Wildlife Management Areas

Five wildlife management areas are located within the subbasin. A list of these areas and their acreage and location were presented in the Existing Conditions section for recreation. These areas are considered significant because of the opportunities provided for outdoor recreation and the protection and management given to biological resources within their confines. Of particular importance is the Roseau River Wildlife Management Area. This 62,000-acre area is located in a region of extensive peatland and contains three waterfowl impoundments with about 10,600 acres of water. It is an important waterfowl production area and provides habitat for moose, deer, sharp-tailed grouse, bobcat, bear, coyote, and

timber wolf (U.S. Fish and Wildlife Service, 1977; Peterson and Enblom, 1978).

Threatened or Endangered Species

Threatened or endangered species that are known or presumed to occur within the subbasin include the Arctic peregrine falcon, bald eagle, and eastern timber wolf. The Arctic peregrine falcon does not breed or nest in this area. It does, however, include all of the subbasin in its wintering range. The Arctic peregrine falcon has experienced a drastic reduction in population in recent years because of the "thinning" effects that chlorinated pesticides (especially DDT) have on the falcon's egg shells. These pesticides are also one of the reasons for the decline of the bald eagle. The loss of habitat is another major reason the bald eagle is now endangered. In contrast to the Arctic peregrine falcon, the bald eagle breeds in this region and winters elsewhere. Active and abandoned nesting sites have been reported from Beltrami, Lake of the Woods, and Roseau counties. The eastern timber wolf's primary range includes portions of Beltrami, Lake of the Woods, and Roseau counties. Kittson and Marshall counties are within the timber wolf's peripheral range. Pressures from civilization such as bounties are the main reasons for the reductions of the wolf populations.

Other Important Species

Several mammal species of special interest have been reported from the counties included in the subbasin. The long-tailed weasel, northern flying squirrel, northern pocket gopher, and northern bog lemming are peripheral species that require additional studies to determine their exact distributions and relative abundance. The American elk is a peripheral species also, but it is one of the rarest mammals in Minnesota. The least weasel is another mammal of special interest because it is uncommon or rare throughout its range in Minnesota. The woodland caribou has been reported from Lake of the Woods County in the past but has been eliminated from its original range in Minnesota.

The eastern greater sandhill crane is considered threatened in the state of Minnesota (Moyle, 1974) and was reported to be nesting in this region

(Department of Natural Resources Region 1N) during the 1978 breeding bird survey. Approximately 700 cranes were reported from the Roseau River area in 1976 (U.S. Fish and Wildlife Service, 1977). No colonial bird nesting sites were reported from the subbasin by the Minnesota Department of Natural Resources in 1978.

Marsh hawks and Franklin's gulls were also reported from this region in 1978. These two bird species have an uncertain or changing status that could be improved or threatened depending on human interference with their habitats. The marsh hawk, however, has shown a slight increase in recent years. The great blue heron also inhabits the subbasin and is a species of special interest because of the presently limited coniferous swamps that it uses for nesting and feeding (Henderson, 1979). The last confirmed report of the prairie chicken in the Roseau area was over 13 years ago. Other uncommon or rare birds that have been reported nesting within the subbasin include the Philadelphia vireo, scarlet tanager, blackpoll warbler, Connecticut warbler, Wilson's warbler, Le Conte's sparrow, Boreal chickadee, great gray owl, sharp-tailed sparrow, and short-billed marsh wren (U.S. Fish and Wildlife Service, 1977).

The Canadian toad and great plains toad are two amphibians of special interest because they are western species in the eastern extreme of their ranges in the subbasin. The smooth green snake is a reptile species of special interest because, although its range is extensive in Minnesota, it requires a very limited habitat of moist, grassy areas usually found in meadows or plains. These areas are currently being used for agricultural purposes.

Carex conoidea, Carex obtusata, Juncus gerardii, Eleocharis halophila, meadow grass, Scottish asphodel, starwort, and small yellow water buttercup are plants found in the wet meadow areas of the subbasin. These plants are classified as rare species by the Minnesota Natural Heritage Program (1980). Orobanche fasiculata is a rare plant that is parasitic on the roots of members of the composite family. This species has been reported from Kittson County. Arabis holboellii var. retrofracta, Helianthus nuttallii, and cat's paws are rare plants indigenous to the dry plains and hills

of the area (Rydberg, 1932; Lakela, 1965; MacMillan, 1898).

Natural Areas

As yet, no scientific or natural areas have been established within the subbasin (the Nature Conservancy, no date).

V. FUTURE CONDITIONS

V. FUTURE CONDITIONS

The subbasin's (United States portion only) "most probable" and "without" project future conditions and resources are presented below and focus primarily on economic trends, population forecasts, and generalized statements of environmental conditions and resources.

Most Probable Economic Conditions

Projections of general economic and demographic indicators for the non-SMSA portion of the Grand Forks area appear to underestimate growth trends that have been noticeable in this vicinity since the early 1970s. OBERS Series E and E' projections have in fact predicted steady decreases in these indicators during the course of the study period. It was thus judged that state, regional, and Gulf South Research Institute (GSRI) developed figures be adopted as the most probable. The Principles and Standards allow for such a deviation if conditions unique to the study area indicate that OBERS may not be totally satisfactory.

Table 11 presents population, employment, and per capita income (in 1979 dollars) figures for the subbasin for the 1980-2030 study period. These figures indicate a stabilization and slow reversal of the population and employment declines that preceded the 1970's, which were a result of mechanization and increased efficiencies of farm processes and the accompanying losses of relatively small farmsteads and the associated employment. Pre-1970 outmigration and natural population decreases in Roseau County were offset primarily by inmigration and, to a lesser extent, by births. Beltrami County, which also encompasses part of the subbasin, will continue to contribute to the population totals, although few people reside in that portion of the county that is within the subbasin.

Agriculture will continue to play an important role in the economy as will the manufacturing and services. The larger communities in the subbasin, particularly Roseau, will experience gains in population as their importance to the area's services and trade sectors increases. The Northwest Regional Development Commission anticipates the town of Roseau to maintain its role as a secondary growth center and notes the need for a number of infrastructure-type projects for the community.

Table 11
ROSEAU RIVER SUBBASIN, POPULATION, EMPLOYMENT, AND
PER CAPITA INCOME PROJECTIONS, 1980-2030

Parameter	1970	1977	1980	1990	2000	2010	2020	2030
Population	7,158	7,779	7,900	8,200	8,500	9,400	10,200	11,300
Employment	2,577	3,189	3,250	3,400	3,500	3,900	4,200	4,700
Per Capita Income (Dollars)	4,419	6,892	9,300	12,600	17,000	22,900	30,900	41,700

Sources: U.S. Water Resources Council, 1972 OBERS Projections, Series E; Minnesota State Planning Agency; and Gulf South Research Institute.

The recurring flooding that affects some 90,000 acres of rural floodplain and Roseau will remain as the single most important subject of concern to the planners and leaders involved with subbasin activities.

Most Probable Agricultural Conditions

Approximately 274,300 acres within the subbasin are currently under cultivation, and wheat, oats, barley, and hay are the principal crops. The estimated value of production in 1980 of these principal crops, using October 1979 Current Normalized Prices for Minnesota, is \$19.9 million. Projections of total production through 2030 for the principal crops is presented in Table 12. The projected total production for 2030 represents a value of \$33.4 million, using October 1979 Current Normalized Prices for Minnesota.

Evaluation of Flood Damages--Future Conditions

A summary of present and future average annual flood damages is presented in Table 13. Assuming a discount rate of 7 1/8 percent, average annual damages throughout the projection period are expected to be \$3.2 million, of which 91 percent is agricultural damages.

Table 12
ROSEAU RIVER SUBBASIN, PRINCIPAL CROPS AND
PROJECTED PRODUCTION, 1980-2030
(Production in Thousands)

Year	Wheat (Bushels)	Hay (Tons)	Oats (Bushels)	Barley (Bushels)
1980	3,575	91	2,347	1,531
1990	4,147	106	2,722	1,776
2000	4,719	120	3,098	2,021
2010	5,077	129	3,332	2,174
2020	5,434	138	3,567	2,328
2030	6,006	153	3,942	2,573

Source: OBERS Series E'; and Gulf South Research Institute.

Table 13

ROSEAU RIVER SUBBASIN, SUMMARY OF PRESENT AND FUTURE AVERAGE ANNUAL DAMAGES
 URBAN, AGRICULTURAL, AND TRANSPORTATION
 (October, 1979 Prices, 7 1/8 Percent Interest)

Category	Flood Damages					Average Annual Increase Factor 1980-2030	Average Annual Equivalency Factor	Average Annual Equivalency of Increase	Equivalent Average Annual Damages
	1980	1990	2000	2010	2020				
Urban									
Roseau	217,400	239,100	260,900	282,600	304,400	326,100	108,700	0.2903	31,600
Agricultural									
Crop	1,832,600	2,125,800	2,419,000	2,602,300	2,785,600	3,078,800	1,246,200	0.2903	361,800
Other Agricultural	610,900	639,800	708,600	739,200	769,700	818,600	207,700	0.2903	60,300
Transportation	39,100	39,100	39,100	39,100	39,100	39,100	--	--	39,100
TOTAL	2,100,000	2,163,800	2,421,600	2,663,200	2,898,800	3,262,600	1,562,600	0.2903	453,700
3,153,700									

Source: Gulf South Research Institute.

Flood damages to residences, businesses, industrial structures, churches, schools, automobiles, house trailers, public property and contents are included in the urban damages category. Damages to streets and utilities (including water, gas, electricity, sanitary sewers, storm sewers, and telephone systems) are also taken into consideration. This category also includes loss of wages, loss of profits, expenditures for temporary housing, cleanup costs, and extra expenses for additional fire and police protection and flood relief.

Agricultural flood damages consist of crop and pasture damage, which may include costs of replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other related flood losses.

Other agricultural damages consist of land damage from scour and gully erosion and deposition of flood debris; livestock and poultry losses; damages to machinery and equipment, fences, and farm buildings and contents (excluding residences); and damages to irrigation and drainage facilities.

Transportation damages include all damages to railroads, highways, roads, airports, bridges, culverts, and waterways not included in urban damages. In addition, all added operational costs for railroads and airlines and vehicle detours are included.

Future growth of urban flood damages was estimated to be an uncompounded (straight-line) rate of one percent per year for a 50-year period beginning in the base year, with no growth thereafter.

Agricultural crop flood damages were projected to increase at the same rate as crop income projections published in the 1972 OBERS Series E projection report. These crop income projections were prepared by the U.S. Economic Research Service (ERS) for the Red River of the North region. Other agricultural flood damages were projected to increase at one-half of this rate.

Transportation damages are not expected to change throughout the project life because of the long-term economic life associated with such structures as bridges, railways, roads, and culverts. In addition, it has been found that repairs to these types of structures rarely exceed the cost of a new structure, even with frequent flooding.

Most Probable Environmental Conditions

Improvements in water quality should occur with successful implementation of point and nonpoint source pollution abatement plans. Those measures directed toward the nonpoint sources are expected to take considerably longer to be implemented. Woodland wildlife habitats are expected to increase, based on land use trends from 1969 to 1977; however, wetlands will decrease in both number and total acreage, with resultant decreases in plants and animals dependent upon these important environments. Water quality improvements will create improved conditions for both aquatic biota and wildlife utilizing surface waters.

The above statements assume that the proposed alternatives, specifically the channel modifications to 43.9 miles of the Roseau River and its associated measures, will not occur. However, the Roseau River Flood Control Project has been authorized and is presently in preconstruction planning. Thus the statements above will not necessarily reflect future conditions, particularly since much concern has been expressed over the effects of this project on the environmental resources of the subbasin. These effects include those related directly to the construction of the project and, more significantly, to the indirect effects brought about by accelerated land use changes. Generally, major adverse impacts associated with the project that would affect fish and wildlife resources include the degradation of the quality of the Roseau River, alteration or elimination of significant terrestrial habitats for wildlife, and potential loss of significant amounts of wetland through increased drainage indirectly associated with the project. Concern has also been expressed relative to the mitigation of the induced wetland drainage processes that may occur (U.S. Army Corps of Engineers, 1976; U.S. Fish and Wildlife Service, 1977; International Roseau River Engineering Board, 1975).

Without Project Conditions

It is likely that the scenario set forth as the most probable future of the subbasin will prevail during the 50-year planning period.

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

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Institutions

The development of effective water resources management practices in the subbasin is affected by the large number of international, Federal, state, and local agencies involved in project planning and implementation. A portion of the subbasin lies within Canada. For the U.S. portion of the subbasin, there are 44 Federal agencies with various types of jurisdiction and 14 directly involved in the water and related land resource planning process. At the state level, 27 agencies are involved. There are also regional commissions, county agencies, and municipal entities. Differences in perspective and problems of coordination hamper the effective and speedy resolution of problems.

The subbasin is aided in water resources development by the inclusion of the area in the Roseau River Watershed District. The Roseau and Kittson soil and water conservation districts also have jurisdiction within the subbasin. No flood control projects have been constructed in the subbasin by the Corps of Engineers or the Soil Conservation Service.

The Corps of Engineers, the Roseau River Watershed District, the Soil Conservation Service, the soil and water conservation districts, and the towns of Hallock and Roseau are the main entities that should be consulted in flood control planning for the subbasin. It should be noted that the Northwest Regional Development Commission has prepared an overall development plan that includes the subbasin.

Structural Measures

Between 1904 and 1918, a network of drainage ditches was constructed adjacent to reaches of the Roseau River between Roseau and Caribou. In addition, a series of channel enlargements, modifications, and diversions was undertaken. These facilities were constructed to reduce flooding and to accelerate drainage in the fertile flatlands northeast of Roseau and around Ross. A bypass channel was excavated to convey a large portion of the Roseau River flow past Roseau Lake on the south side, and a ditch draining the lake was connected to the modified channel, thereby opening

this area for agricultural activity. Further downstream of Ross, major channel modifications in the Big Swamp reach of the Roseau River reduced upstream flooding by providing a more effective exit for floodwaters. Drainage facilities constructed in Big Swamp parallel to the Roseau River also reduced upstream flooding. Additional drainage works have been constructed in the Roseau-to-Caribou reach since 1920, but on a smaller scale than the primary network built between 1904 and 1918.

An earthen dam constructed in 1953 on Pine Creek diverts flows from the main channel into the Pine Creek Diversion channel (Figure IV). An 18-inch gate-controlled culvert through the dam permits low flows to pass down the natural channel of Pine Creek if desirable or necessary. Operating plans provide for diverting flows up to 450 cfs into the Roseau River Wildlife Refuge. The Pine Creek diversion system reduces flows in the natural channel, while increasing the flows along the diversion channel. The diversion channel is designed for a maximum flow of 600 cfs, which has about a one-in-15 year recurrence interval.

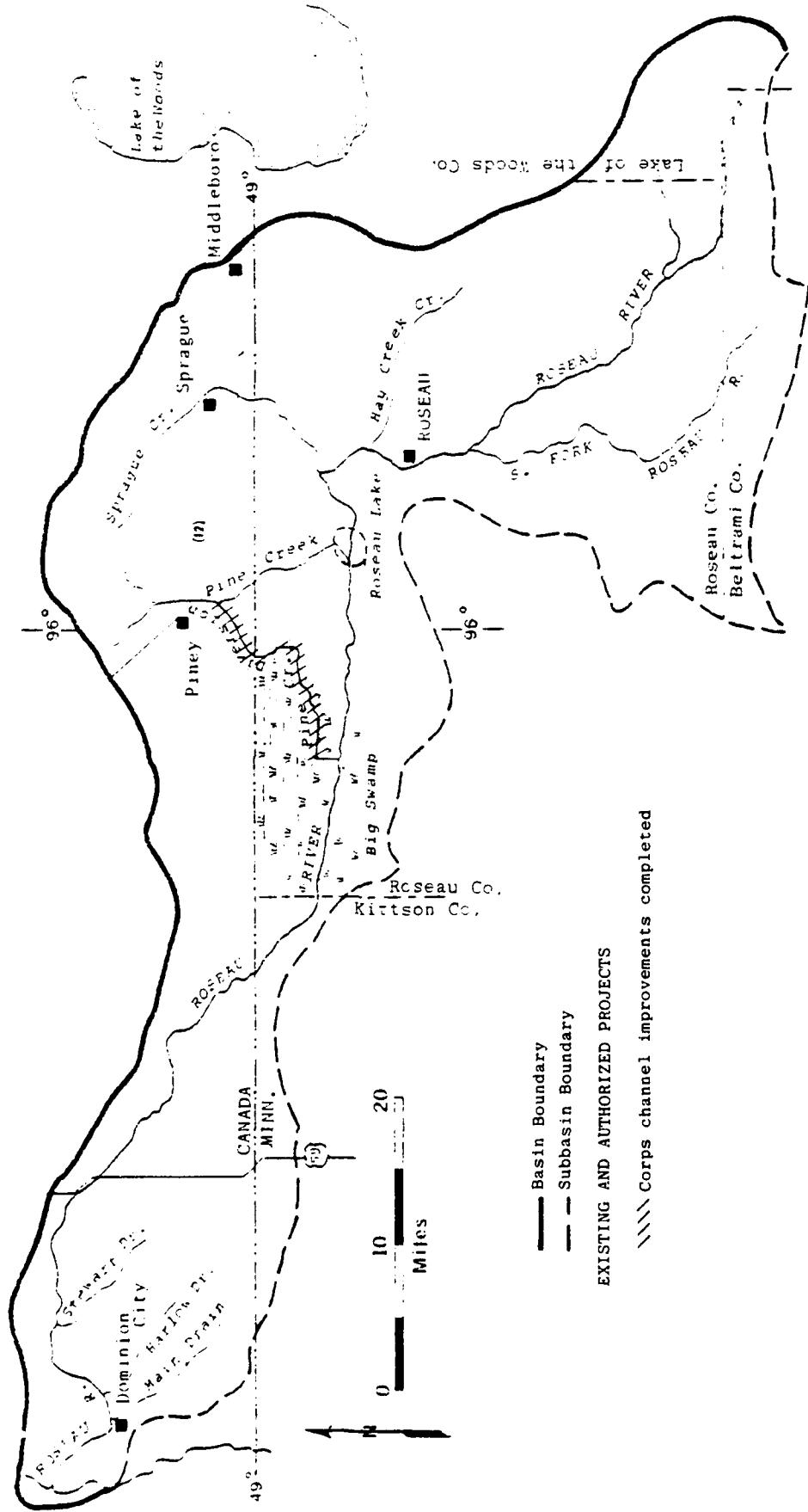
Three dams are located in the subbasin: Roseau Dam, Hayes Lake Dam, and wildlife impoundments. However, these dams were not constructed for flood control purposes and, as such, have little impact on the flooding problems in the subbasin.

Emergency levees were built in 1965 on both the east and west banks of the Roseau River throughout the city of Roseau. These levees have only provided localized flood protection.

Nonstructural Measures

Nonstructural flood control measures are measures that reduce or eliminate flood damages through procedures that involve little if any construction efforts. The major types are flood warning, floodplain zoning, flood insurance, flood proofing, and floodplain evacuation. These measures are primarily applicable to urban areas.

The city of Roseau participates in the Federal Flood Insurance Program and has a floodplain zoning ordinance, building codes, and subdivision regulations for floodplain areas. Roseau also participates in the Red River Valley flood warning system. The flood warning system for the Red River Valley is a cooperative network organized by the National Weather



Source: Gulf South Research Institute.

Figure IV. EXISTING FLOOD CONTROL MEASURES

Service in Fargo, North Dakota. Fifty volunteers throughout the basin report to the National Weather Service on a weekly basis during winter and fall and on a daily basis during spring and summer. The reportage covers all precipitation of 0.1 inch or more, including amounts of snow and water equivalent. This information is transmitted to the River Forecast Center in Minneapolis where it is run through a computer system to determine probable flood stages. The predictions are then transmitted to the National Weather Service in Fargo, which releases them to the public through the news media. Communities are then able to engage in emergency actions to protect themselves from flood damages. Contacts with local officials indicate that the flood warning system generally works quite well in the subbasin.

The subbasin is located in Kittson and Roseau counties, both of which participate in the flood insurance program. In addition, Roseau County has a floodplain zoning ordinance, a building code, and subdivision regulations for floodplain areas.

There are other types of measures that could be implemented in the subbasin to reduce flood damages but that are not directly applicable to urban areas. These measures would include such things as land treatment programs, use of present drainage ditches for floodwater storage, and use of natural areas for reversion to water retention use. Land treatment is used by some farmers in the subbasin, but the SCS has not been called upon to undertake a large-scale program. Present drainage ditches are not used for floodwater storage, and no plans have been developed for future use.

Information on natural storage areas and potentialities for increased storage is limited. Indications are, however, that wetlands play a substantial role in controlling runoff, especially in combination with good land treatment practices. Values on storage have averaged about 12 inches per surface-acre of wetlands, and have ranged to four times that amount (Cernohous, 1979). The amount of wetland habitat within the watershed area (or subbasin) is important: studies indicate that in certain situations if a watershed has 15 percent of its area in wetlands or lakes, peak floods will be 60 to 65 percent lower than they would be in the absence

of the wetland/lake area; if wetlands or lakes occupy 30 percent of the watershed, there will be a further reduction in flood peaks up to about 75 to 80 percent (Scientists' Report, National Symposium on Wetlands, 1978).

Adequacy of Existing Measures

The principal natural drains are Hay Creek, Sprague (Mud) Creek, Pine Creek, and Badger Creek. Most of these natural drains have been modified and incorporated as part of a legal drainage organization. The channels of these tributaries, both natural and modified, have inadequate capacities to provide good drainage for their watersheds, and lack of maintenance of some of these channels aggravates the situation. Consequently, most of the existing ditches cannot function satisfactorily because of poor outlet conditions along with inadequate maintenance.

The Pine Creek Diversion was created for the purpose of supplying water to three wildlife pools in the Roseau River Wildlife Refuge; however, even though this channel is designed for a flow equivalent to a 6.6 percent (15-year) recurrence interval, its effect on flood reduction in the subbasin has been negligible. Emergency levees in Roseau do not meet the Corps of Engineers design criteria and do not provide effective protection for a 100-year flood.

VII. CRITERIA AND PLANNING OBJECTIVES

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Floodplain Management Criteria

Technical, economic, and environmental criteria must be considered when formulating and evaluating alternative floodplain management measures for the subbasin.

The technical criteria used in formulating and evaluating alternatives for this report consisted of the application of appropriate engineering standards, regulations, and guidelines.

Economic criteria entailed the identification and comparison of benefits and costs of each measure. Tangible economic benefits or appropriate gains in environmental quality must exceed costs; however, in certain instances, considerations of appropriate gains in the other accounts (environmental quality, social well-being and regional development) could alter this requirement. All alternatives considered are scaled to a design which optimizes benefits. Annual costs and benefits are based on an interest rate of 7 1/8 percent and price levels and conditions existing in October 1979. A 50-year amortization schedule is used for the features considered.

Environmental considerations call for the formulation of measures that minimize objectionable or adverse environmental effects and maximize environmental benefits. Also, limited consideration was given to modifications based on coordination with state and Federal agencies, local interests, and citizen groups.

Planning Objectives

The primary planning objective of this study was to contribute to flood reduction needs in the subbasin and thereby provide protection from or reduction of flood losses. In conjunction with this economic objective, the study attempted to develop contributions to the environmental quality of the subbasin.

The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin from the information that was available. On the basis of this analysis of the problems, needs, and desires that could be identified, the following objectives were established:

1. Contribute to protection from and prevention, reduction, or compensation of flood losses for the flood prone areas of the subbasin during the period of analysis.
2. Contribute, to the maximum extent possible, to the preservation of the quality of the existing riverine environment and enhance the environmental potential of the subbasin as a whole.
3. Contribute to the enhancement of recreational opportunities throughout the subbasin.
4. Contribute to the improvement of water quality in the River.
5. Contribute to the reduction of wind and water erosion throughout the subbasin.
6. Contribute to the developing trend toward increased irrigation throughout the subbasin.
7. Contribute to the reduction of wastewater management problems, particularly insofar as they relate to water quality.

VIII. FORMULATION OF ALTERNATIVE MEASURES

VIII. FORMULATION OF ALTERNATIVE MEASURES

This section contains a discussion of management measures that have been identified to meet the resource management objectives. In the formulation of measures, prime consideration was given to the resolution of flooding problems. Measures to satisfy the other planning objectives were considered exclusively as components of the flood control measures.

Authorized Measures

Congress has authorized a flood control project in the subbasin consisting of the following: (1) 43.9 miles of channel improvements on the Roseau River, extending downstream from the dam at Roseau to a point near the International Boundary; (2) Construction of three short reaches (about 9 miles in length) of paralleling levee on the left bank; and (3) channel improvement of about 10.2 miles of the Roseau River in Canada. This latter improvement is required because the upstream improvements will cause a small increase in peak flows at the boundary for all peaks not exceeding 6,000 cfs. These measures are shown in Figure V.

Improvements in this project will reduce flooding on approximately 55,000 acres of agricultural land along the Roseau River in Minnesota between the city of Roseau and Big Swamp, and would decrease the frequency and duration of flooding on an additional 22,000 acres of floodplain below Big Swamp. Within Big Swamp and along the reach of river downstream to the boundary, little or no reduction in peak flood levels will result from the project, since the modified channel will be designed to minimize the increase in magnitude of flood peaks at the international border. Roseau River channelization maintains the overflow into Two Rivers Subbasin at preconstruction levels. Flows to Canada are altered which necessitates mitigation payment to that country. Reduction of Roseau River flood flows into the Two Rivers area would increase flood flows to Canada.

Upstream from Big Swamp, the degree of protection afforded by the project will vary as follows:

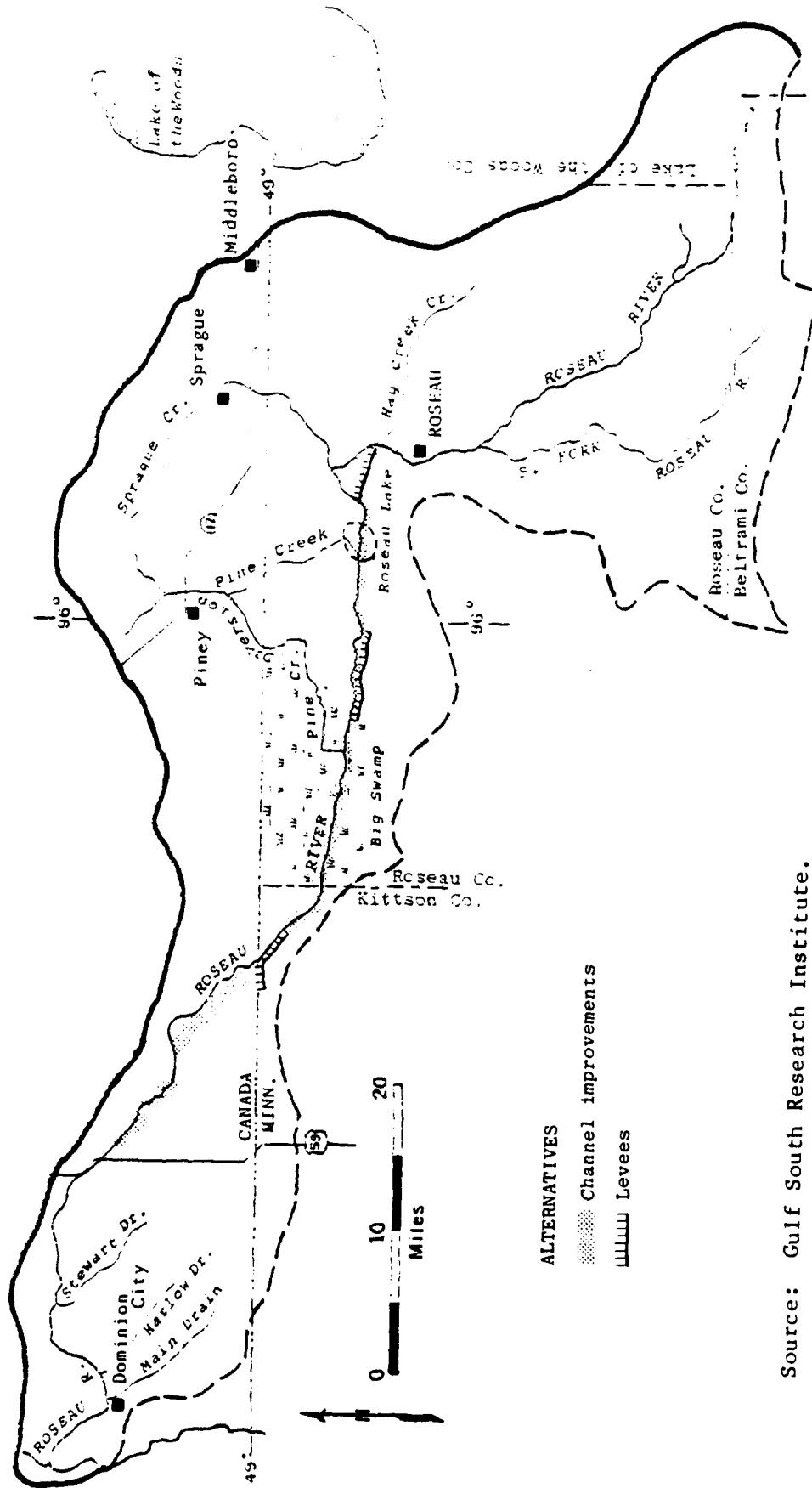


Figure V. ALTERNATIVE FLOOD CONTROL MEASURES

Source: Gulf South Research Institute.

From Big Swamp upstream through Roseau Lake: 10-year frequency
Roseau Lake to Roseau Dam: 10-year frequency to 50-year frequency
Roseau Dam to upstream limit of city of Roseau: 50-year frequency
decreasind to 30-year frequency

The Corps of Engineers investigated several other alternatives along with the previous authorized project in a general design memorandum completed in 1971. Aside from the authorized project, other structural alternatives that were considered included:

1. Reservoir Storage: Reservoirs were considered at Roseau Lake and in the Big Swamp area. Because of local opposition and unfavorable benefit-cost ratios, this alternative was eliminated.
2. 100-Year Protection at Roseau: The construction of flood barriers, levees, and interior drainage facilities was investigated to eliminate flood damage at Roseau. However, annual costs were far greater than the annual benefits that would be derived.
3. 50-Year Protection at Roseau: This alternative entailed the construction of an 80-foot wide channel upstream of the dam at Roseau and appropriate enlargement of the channel downstream of Roseau to Richardson's Bridge. This project also lacked economic feasibility.
4. Levees: Construction of a complete system of levees along the Roseau River that would provide a significant level of flood protection to portions of the subbasin was considered. Because of adverse environmental factors and an unfavorable benefit-cost ratio, this alternative was not considered viable.
5. Reservoir Storage Plus Channel Modifications: This alternative consisted of a combination of reservoir storage in Big Swamp (Alternative 1) and the authorized channel modifications from the upstream limits of Big Swamp to the city of Roseau. These facilities would provide the upstream protection afforded by the authorized project and would reduce the need for the authorized downstream channel work. This would eliminate the impacts of downstream channel modification.

In addition, on the average, flooding downstream from Big Swamp would be reduced, overflows into the Two Rivers Subbasin would be reduced, Canadian mitigation would probably be less extensive, and fish and wildlife benefits would accrue in the Big Swamp area. An unfavorable benefit-cost ratio also eliminated this alternative from further consideration.

Alternative Measures

Upon construction of the authorized project, no serious flood problem areas should remain in the Roseau River Subbasin as it will protect against (except rare floods) 10-percent chance floods in rural areas and 50-percent chance floods in Roseau. However, localized areas will still be subject to some flooding during snowmelt and severe rainfall periods, especially rural areas in poorly drained sections. Construction of levees around farmsteads averaging 5.0 acres in size situated in these flood-prone areas would provide protection against a 1.0 percent (100-year) frequency flood and could be constructed by private individuals, the Corps, or the SCS.

Nonstructural Measures

Nonstructural measures can often effectively reduce flood damages and were considered for flood-prone areas along the Roseau River in planning reports for the authorized project. Nonstructural measures considered include floodplain evacuation, emergency protection, and flood proofing. These measures are most effective in reducing flood damages to urban areas and, in general, are ineffective in reducing damages to large agricultural areas.

According to the planning reports, biological impacts resulting from implementation would be minimal and localized. Permanent evacuation of the floodplain area is totally unacceptable to local interests. The emergency flood protection plan would be dependent on an effective flood warning system to provide the lead time necessary for implementation of emergency protection measures. Given the existing flood warning system and time and funding constraints, emergency protection measures would probably be unsatisfactory in regard to safety, degree of protection, and aesthetic appearance. In addition, emergency local protection, consisting of levees, channel work, and similar efforts, would reduce flood losses in the protected areas, but could also increase flood stages in other unprotected areas downstream.

Because of the unacceptable social impacts and the probable limited reduction of flood damages, nonstructural measures alone could not be considered viable flood control alternatives. Some of these measures, however, in combination with other nonstructural measures, could provide an alternative which might afford a more permanent solution to many of the flooding problems within the subbasin.

IX. ASSESSMENT OF ALTERNATIVES

IX. ASSESSMENT OF ALTERNATIVES

Economic Assessment

Economic evaluation of the proposed flood control measures for the subbasin is summarized in Table 14. Alternative one consists of: (1) 43.9 miles of channel improvements on the Roseau River, extending downstream from the dam at Roseau to a point near the International Boundary; (2) construction of three short reaches (a total of nine miles in length) of paralleling levee on the left bank; and (3) channel improvements of about 10.2 miles of the Roseau River in Canada. This latter improvement is required because the upstream improvements will cause a small increase in peak flows at the International Boundary.

Alternative two consists of the construction of levees around individual farmsteads as previously discussed. Economic evaluation of this alternative yielded a benefit/cost ratio of 2.10.

Impact Assessment

Table 15 provides a generalized assessment of anticipated impacts on various key elements of the United States portion of the subbasin that would result from the alternative measures considered. The rationale used in developing the ratings is also presented below. A brief discussion of the effect of these flood control measures on Canada is also presented.

Channel Improvements and Levees

The St. Paul District Corps of Engineers' document and supplement entitled Final Environmental Impact Statement, Flood Control, Roseau River, Roseau and Kittson Counties, Minnesota provides the basis for discussion of anticipated impacts of 43.9 miles of channel improvements on the Roseau River plus construction of three short reaches of paralleling levees. This alternative would result in maximally beneficial social and economic effects; maximally adverse biological impacts; moderately adverse land use, water quality, and recreation effects; minimal negative impacts on cultural resources; and no effects on water supply.

Social and economic benefits would accrue from the flood protection and flooding reduction that would stem from the measures. Maximum direct social impact of the measures would involve rural residents along that

Table 14
ECONOMIC EVALUATION OF ALTERNATIVES

Alternatives	Acre Protected	Average Annual Acres	Capital Costs	Average Annual Costs	Average Annual Rural Benefits	Average Annual Urban Benefits	Total Annual Benefit ¹	Average Annual Benefit ²	B/C Ratio
Channel Improvements and Levees	55,000	--	\$21,355,000	\$916,000 ¹	\$840,000	\$309,000 ²	\$1,149,000	1.25	
Farmstead Levees (per levee)	--	--	\$5,600	\$400	\$40	--	\$40	2.10	

¹ Annualized using 3 1/4 percent interest rate as authorized by Congress.

² Includes \$69,000 of area redevelopment benefits.

Source: Gulf South Research Institute.

Table 15
ASSESSMENT OF MEASURES, BY RESOURCE ELEMENT,
ROSEAU RIVER SUBBASIN

Measures	Social	Economics	Land Use	Biology	Water Quality	Water Supply	Cultural	Recreation
Channel Improvements and Levees	MaB	MaB	MoA	MaA	MoA	NKE	MiA	MoA
Farmstead Levees	MiB	MiB	NKE	NKE	NKE	NKE	NKE	NKE

Note: NKE = Negligible or No Effect
 MiA = Minimally Adverse
 MoA = Moderately Adverse
 MaA = Maximally Adverse

MiB = Minimally Beneficial
 MoB = Moderately Beneficial
 MaB = Maximally Beneficial

Source: Gulf South Research Institute.

portion of the Roseau River to be modified as well as the inhabitants of the town of Roseau. Public health benefits and reduced safety hazards from flooding conditions would also be experienced. No displacement of people or farms is anticipated.

Some 55,000 acres of Roseau River floodplain would experience reduced flood stages, and average urban benefits of approximately \$300,000 (particularly to the community of Roseau) would take place. Other beneficial economic effects include increased agricultural output and incomes, reduced unemployment due to construction, and enhancement of the area's agricultural base.

Severe adverse biological and moderately adverse water quality effects can be anticipated. Streambank clearing and snagging operations and/or channelization would be maximally adverse to the Roseau River. These measures would result in: (1) greater extremes of water temperature; (2) loss of aquatic and riparian habitat; (3) water quality degradation; (4) increased siltation; (5) increased velocity; and (6) reduced flows in summer months. Several threatened, endangered or otherwise important species inhabit the subbasin and use the Roseau's riparian community as a traveling corridor.

Land use and recreation elements would also be moderately adversely affected. The conversion of floodplain land to agriculture and the encouragement of development in the floodplain would create negative land use impacts. Recreational use of the river during boating season would decrease because of diminished low-flow depths. The realignment and enlargement of the channel would be detrimental to aesthetics. Area hunting and fishing would undergo long-term changes that would negatively affect both local residents and visitors.

During the development of flood control alternatives for the project, three archaeological sites were identified within proposed construction areas. Adjustments to specifications can, however, insure that impacts can be avoided at one of the two sites. The third site has been tested, and no further work on it is recommended.

The channel modifications planned for the Minnesota section of the Roseau River would result in increased flooding downstream from the international border. Several mitigation measures have been determined and negotiations are pending. It is anticipated that Canada would experience several

moderately detrimental riverine environment effects. In addition, the Minnesota channel modifications would have a small detrimental effect on Canada's terrestrial wildlife. Mitigation projects in Canada might result in habitat losses.

Farmstead Levees

Minimally beneficial economic and social effects would result from the protection of several farmsteads in the 100-year floodplain. All other resource elements would not be significantly affected, although consideration must be given to public health and aesthetic factors prior to their construction.

X. EVALUATION

X. EVALUATION

Two alternative structural measures considered for the subbasin have benefit/cost ratios that exceed unity. They are Roseau River channel improvements and associated levees and the farmstead levees.

The authorized Roseau River project would meet the flood protection needs of the subbasin and would best meet National Economic Development (NED) objectives. Total project benefits are greater than costs, and substantial flood damage reductions would result. The social well-being (SWB) account would be enhanced by public health and safety improvements and flood damage reductions, but would be detrimentally affected by recreational opportunity losses. The Environmental Quality (EQ) account would receive basic changes, most of which are negative.

Of the many alternatives considered in previous reports on the Roseau River, the one that appeared to be the most likely to aid in "preserving, creating, and enhancing environmental quality" was reservoir storage within the limits of the Roseau River. Although this alternative was not considered for further investigation in this study because of a previously computed benefit/cost ratio below unity, it should be noted that wildlife benefits accounted for more than 90 percent of the total estimated reservoir benefits.

The farmstead ring levees also exceed the above unity criteria but do not benefit the overall resolution of subbasin flooding problems. National Economic Development and Environmental Quality plans will be tentatively formulated in association with the Red River of the North Basin's main reconnaissance report.

XI. ADDITIONAL STUDY NEEDS

XI. ADDITIONAL STUDY NEEDS

This report was developed almost entirely on the basis of secondary information from readily available planning documents. Data available from state and Federal agencies was not fully canvassed, and only a limited number of calls were made to the area. In particular, state university libraries and department resources could not be fully utilized. Thus, the document aims only at a broad-brush perspective. In order to provide a more detailed and in-depth analysis of subbasin resources, problems, and potential solutions, the following additional study needs would have to be fulfilled:

1. Information pertaining to wastewater management needs to be updated.
2. The secondary, or indirect, impacts of the proposed channel modification need to be ascertained, especially with regard to potential wetland losses described by the U.S. Fish and Wildlife Service (1977).
3. The potential of wetland restoration for use in floodwater storage needs to be determined, as has been indicated by Cernohous (1979). This is particularly significant in those areas where the peat soils of drained wetlands are too wet during some years to be cultivated for production of crops.
4. Nonstructural flood damage reduction measures should be thoroughly explored such as those listed below.
 - Establishment of buffer areas and curtailment of inappropriate residential, commercial, and other development in floodplains.
 - Maintenance and enhancement of existing riparian vegetation along the Roseau River and tributaries to conserve and restore wildlife habitats, help control wind and streambank erosion, retain soil on the land, and reduce the amount of sediment, nutrients, and other pollutants entering waterways.
 - Maintenance of grassed waterways to reduce erosion.
 - Establishment of vegetation in areas of critical erosion.
 - Determination of the feasibility of installing water control structures at existing culverts to retain water in drainage ditches for longer periods of time during critical runoff periods to minimize flooding in downstream areas.

- . Determination of the feasibility of utilizing "on-farm storage" to control runoff through such means as natural storage areas and control structures on existing culverts.
- . Prevention of overgrazing on grasslands and utilization of sound agricultural land use practices.
- . Provision for strict enforcement of floodplain management programs within the subbasin.

5. The potentiality for land treatment measures (e.g. erosion control measures such as cover crops, green belts, reduction in fall tillage, etc.) needs to be thoroughly investigated.
6. Determination of existence of wetlands in areas proposed for implementation of farmstead levees.
7. The people of the subbasin need to be included in further water resource planning efforts. A public involvement program would provide more complete information on water resource problems and opportunities than is presently available.
8. Studies are needed to determine additional demand for recreational facilities, usage of existing facilities, and potential sites.
9. A review of secondary sources and systematic field reconnaissance is needed to identify archaeological and historical sites and to determine their eligibility for nomination to the National Register of Historic Places.
10. A detailed social profile of the subbasin is needed.
11. A detailed institutional analysis of the subbasin is needed.
12. Subbasin boundaries need to be better defined on the basis of hydrologic conditions, and total acreage in the subbasin needs to be precisely measured.
13. An adequate 100-year floodplain map needs to be developed. Also, the extent of floodplains for smaller frequency storms needs to be delineated.
14. Land use within the floodplain needs to be precisely identified.
15. The irrigation potentials of the subbasin soils need to be investigated.
16. The effect of drainage works on flood discharges and stages is unknown at present. It would take additional, more detailed studies to determine the extent and effect of reduced natural storage, and the relationships with levee and channel measures.

17. Whether forested acreages in the floodplain are increasing or declining needs to be precisely determined.
18. More study is needed to determine the precise nature of the water supply problems and potential solutions.
19. More gauging stations need to be developed to provide hydrologic data for establishing flood frequencies and rating curves.
20. Channel cross-sections of the various streams need to be prepared for flood control planning purposes.

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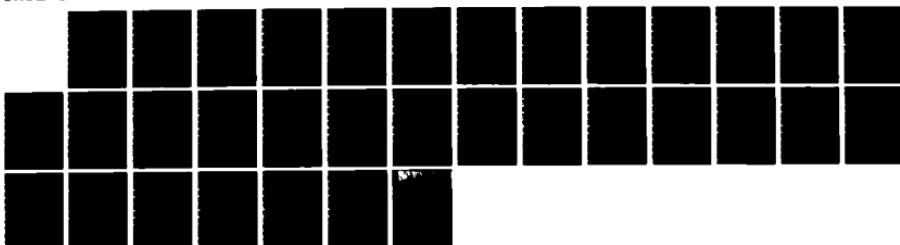
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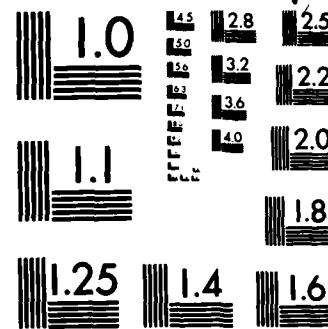
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Appendix A
FLOODPLAIN DELINEATION

Appendix A FLOODPLAIN DELINEATION

Prior to this study, no attempt was made to publish even a generalized delineation of the entire Roseau River floodplain. In undertaking this task, the present study utilized all known sources to provide the best available data for generalized delineation of the U.S. portion of the subbasin at a scale of 1:250,000. Principal sources were: USGS Flood Prone Area Maps (scale 1:24,000), Federal Insurance Administration flood maps (various scales), published secondary sources, U.S. Geological Survey (USGS) 7 1/2 minute topographic maps, and other sources, including derived data where necessary.

The Flood Prone Area Maps published by the USGS provided detailed and highly accurate information for the area mapped. Two sheets covering the area near the city of Roseau represent the available coverage. Since this particular area is the only major urban area within the U.S. portion of the subbasin, the delineated 100-year flood zone proved extremely helpful.

Federal Insurance Administration Flood Hazard Boundary Maps and Flood Insurance Rate Maps provide important coverage of the Minnesota portion of the Red River Basin. The former are designed only to delineate the 100-year floodplain. The latter are much more detailed and usually more accurate. A Rate Map for Roseau County provided most of the detail in the Figure II delineation. Boundary Maps for Kittson and Beltrami counties were consulted, although the area involved is relatively small. Marshall and Lake of the Woods counties also involved small areas, but are peripheral to the Roseau River and do not contain floodplain areas.

Secondary sources, such as the Souris-Red-Rainy River Basins Type II Study were also utilized. Published floodplain descriptions and acreage estimates in the 1976 Final EIS, Flood Control-Roseau River and the 1976 International Joint Commission, Coordinated Water Use and Control Study contained helpful information regarding the location and extent of the floodplain. USGS 7 1/2 minute topographic maps of relevant areas were also available for consideration.

Because of the general availability of data for the U.S. portion of the subbasin, inferences were minimal. Data from the sources identified was compiled and delineated on USGS 250,000-scale maps. The floodplain indicated was then planimetered with figures in square inches converted to land measure and rounded to the nearest 2,000 acres.

Appendix B: INVENTORY OF OUTDOOR RECREATIONAL
FACILITIES (WILDLIFE MANAGEMENT
AREAS) ROSEAU RIVER SUBBASIN

Appendix B
INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
ROSEAU RIVER SUBBASIN

<u>Number</u>	<u>Name</u>	<u>Location</u>	<u>Boundary Acres</u>	<u>WMA Managed Acres</u>	<u>Date¹</u>
1	Joe River WMA	Kittson Co. 16449W34 Joe River	80.0	80.0	71
2	Roseau River WMA	Roseau Co. 16444W35 Duxby	86,000.0		71
3	Roseau WMA	Roseau Co. 16340W17 Ross	6,865.0		71
4	RC 3 WMA	Roseau Co. 16338W22 Salol	80.0	80.0	71
5	Enstrom WMA	Roseau Co. 16238W05 Salol	236.1		76
Total Acres:			93,261.1	160.0	

¹Date of latest information.

Source: Minnesota Department of Natural Resources, Division of Parks and Recreation.

Appendix B
INVENTORY OF OUTDOOR RECREATION
ROSEAU RIVER SURFACE

Number	Name	Own	Administration	Location	Boundary Acres	Campground				
						Number of Resort Units	Primitive	Modern	Group	Wildlife Management Acres
1	Roseau Park and Recreation Area	Municipal		Roseau Co. 16240W24 Roseau	40.0	10	10			
2	Beltrami Island State Forest	State	DNR ⁶	Roseau Co. 16137W35 Pencer	121,680.0					
3	Hayes Lake State Park	State	DNR	Roseau Co. 15938W12 Pencer	29,600.0					
1	Roseau School Forest	School		Roseau Co. 16240W00 Roseau	320.0					
2	Roseau Municipal Golf Course	Municipal		Roseau Co. 16240W24 Roseau	60.0					

¹ Facilities included are limited to those with 15 or more acres.

² Boat rental.

³ Boat storage.

⁴ Parking spaces.

⁵ Date of latest facility information.

⁶ Department of Natural Resources.

Source: Minnesota Department of Natural Resources, Division of Parks and Recreation.

Appendix B

Y OF OUTDOOR RECREATIONAL FACILITIES¹ ROSEAU RIVER SUBBASIN

9

2

Appendix C
COMMENTS

Appendix C COMMENTS

The purpose of this subbasin report was to provide an overview of the water and related resource problems and needs and to assess potential solutions. Toward this end, draft copies of this report were circulated to Federal, State, and local agencies and comments were sought.

This review resulted in complete and factual documentation. Thus, the study should serve as a building block for the timely completion of future water resource efforts within the subbasin. Further cooperative efforts are, however, needed to evaluate these tentative results and to develop potential solutions.

A distribution list and copies of the comments made with respect to the draft report are included as part of this appendix. Comments that resulted in specific modifications to the draft text are marked by an asterisk.



DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

13 August 1980

Mr. Mike Liffmann
Project Manager
Gulf South Research Institute
8000 GSRI Avenue
Baton Rouge, Louisiana 70808

Dear Mr. Liffmann:

The draft Roseau River subbasin report was distributed for review and comment. Most of the reviewers have sent their comments to us.

- a. Inclosure 1 includes letters from various Federal and State agencies.
- b. Inclosure 2 is the general office comments that need to be considered when preparing the final Roseau River subbasin report and the remaining subbasin reports.
- c. Inclosure 3 identifies specific office concerns that are applicable to the final Roseau River subbasin report.

If you have any questions on our comments or proposed modifications, please contact us.

Sincerely,

Louis E. Kowalski
LOUIS E. KOWALSKI
Chief, Planning Branch
Engineering Division

3 Incl
As stated

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

316 North Robert Street, St. Paul, Minnesota 55101

June 20, 1980

Colonel William W. Badger
District Engineer
U. S. Army Corps of Engineers
1135 U. S. Post Office & Custom House
St. Paul, MN 55101

Attention: NCSED-PB

Dear Colonel Badger:

The Soil Conservation Service has reviewed the draft reports for the Roseau River and Two Rivers Subbasins, prepared by GSRI. The following comments are offered for your consideration:

Roseau River Subbasin

- * 1. Page 9, 1st paragraph - Do the figures given in the last sentence refer to wetland acreage or flood plain acreage?
- * 2. Page 10 - Insert "million" after \$21.7 on the last line of the page.
- * 3. Page 11, last full sentence on page - Page 22 and this sentence indicate that 37.9% of the land is cultivated. What does the 50.5% figure refer to?
- * 4. Page 59, 2nd paragraph, item (2) - Suggest rewording as follows, "...existing lateral ditch system as identified in the Duxby Watershed application for PL-566 assistance, to be constructed by others; and..."
- * 5. Page 64, 2nd paragraph, item (3) - Suggest rewording as follows, "(3) improvements to the existing lateral ditch systems as identified in the Duxby Watershed application for PL-566 assistance; and ..."
- 6. Pages 70 and 71, item 4 - Maintenance of grassed waterways, establishment of vegetation, prevention of overgrazing do not need additional study. These are items that need to be carried out. This would apply to item 5 also.

7. Page 71, item 6 - Suggest this be deleted. It is not likely that farmsteads would be built in wetlands. Also, this would be determined on a case by case basis as plans are developed.

Two Rivers Subbasin

1. Page 12 - The last paragraph mentions the Joe River. Since this is the first mention of this tributary, it should be identified as to its location, size, etc.
2. Page 54 - The Badger-Skunk Creek Subwatershed should be located on the map on page 55.

Thank you for the opportunity to review these draft documents.

Sincerely,



Jon V. DeGroot
Asst. State Conservationist



United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

St Paul Field Office, Ecological Services
538 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

July 28, 1980

Colonel William W. Badger
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This provides U.S. Fish and Wildlife Service comments on the Draft Reconnaissance Report recently compiled by Gulf South Research Institute for the Roseau River Subbasin in Kittson, Roseau, Marshall, Beltrami, and Lake of the Woods Counties in Minnesota and Manitoba Province in Canada.

As expressed in our comments on previous Subbasin Reports, our concerns are associated with the woodland, grassland, wetland, riverine and riparian floodplain habitats that remain within the Roseau River Subbasin. The Report indicated that approximately 150,000 acres of exceptionally high quality wildlife habitat still exists within the Subbasin. The heaviest woodland areas are located near the Canadian Boarder, along the Roseau River and other tributary streams, and in the southeastern part of the Subbasin. However, along the Roseau River between the city of Malung and the Canadian Boarder, the woodland vegetation has been reduced in some areas to a narrow band only 50 to 100 feet wide. We agree with the statements on pages 11, 39 and 40 of the Report that these woodlands are important because of their value for wildlife and should be protected, preserved, and enhanced within the Subbasin. A significant amount of wetland habitat also still exists within the northern and southern part of the Subbasin, in the Big Swamp area, and within the Pine Creek, Prague Creek, and Hay Creek watersheds. We agree with the statement on page 12 and 41 of the Report that the drainage of wetlands for agricultural uses is a major problem within the Subbasin and that measures should be undertaken to conserve, protect, and enhance these extremely important wetland areas because of their wildlife habitat value and the many other beneficial functions they perform.

The Roseau River is also of major concern because of its important fishery value. This river has been identified by the Minnesota Department of Natural Resources as having one of the best game fish populations (particularly walleye and northern pike) of all warm water streams in Minnesota. As such, no measures should be undertaken that would inappropriately degrade this important riverine resource.

Other important wildlife and recreational resource areas of concern include the Big Swamp Area, Roseau Lake, Hays Lake, Hay Creek, Sprague Creek, Pine Creek, Badger Creek, Bemis Hill Creek, Hayes Lake State Park, Beltrami Island State Forest and the five State Wildlife Management Areas within the Roseau River Subbasin.

The Report addressed seven structural alternative measures that have been considered to reduce the flooding problems within the Subbasin. The Report indicated, however, that only two of these measures (the authorized Roseau River flood control project and farmstead levees) had favorable benefit/cost ratios and appeared to be economically feasible. Our comments relative to each of these measures are as follows:

Alternative 1 (Authorized Roseau River Flood Control Project)

This project would involve the construction of levees, channel cutoffs, side-ditch inlet structures and about 54 miles of channel improvements on the Roseau River. Our remaining concern with this project is the potential loss of a significant amount of wetland habitat due to wetland drainage directly or indirectly associated with the project. This project would be considered acceptable to the U.S. Fish and Wildlife Service only if adequate measures are taken to ensure that induced wetland drainage does not occur.

Alternative 2 (Farmstead Levees)

This alternative would involve the construction of levees around farmsteads in flood-prone areas to provide protection against a 1.0% (100-year) frequency flood. We do not anticipate any significant adverse environmental impacts due to this alternative provided that the dikes are not constructed through wetland areas and impacts to existing woodland and grassland vegetation are avoided to the extent possible.

Our comments relative to the other structural measures (channel improvements, agricultural levees, reservoirs) addressed in the Report are similar to those provided on previous Subbasin Reports. We believe a plan involving a combination of structural and nonstructural measures (as provided on page 4 of our May 8, 1980 letter on the Draft Reconnaissance Report for the Tamarac River Subbasin) should be implemented.

We also believe that additional studies (particularly numbers 2, 3, 4, 5, 6, 16, and 19 identified on pages 70-72 of the Report) need to be undertaken to provide a more detailed and in-depth analysis of existing Subbasin problems and the potential solutions to many of these problems.

In addition, we suggest that the following changes be made in the Final Report:

*1. Page 41, last paragraph under the heading Waterfowl Production Areas - change this paragraph to read as follows:

Waterfowl Production Areas (WPA's) are wetland areas that the U.S. Fish and Wildlife Service has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting, and feeding habitat for migratory waterfowl. There are no WPA's (fee or easement) presently located within the Roseau River Subbasin.

*2. Page 55, 2nd paragraph, last sentence - we suggest this sentence be changed and the following statements be included in this paragraph:

Information on natural storage areas and potentialities for increased storage is limited. Indications are, however, that wetlands play a substantial role in controlling runoff, especially in combination with good land treatment practices. Values on storage have averaged about twelve inches per surface-acre of wetlands, and have ranged to four times that amount (Cernohous, 1979). The amount of wetland habitat within the watershed area (or Subbasin) is important: studies indicate that in certain situations if a watershed has 15 percent of its area in wetlands or lakes, peak floods will be 60 to 65 percent lower than they would be in the absence of the wetland/lake area; if wetlands or lakes occupy 30 percent of the watershed, there will be a further reduction in flood peaks up to about 75 to 80 percent (Scientists' Report, National Symposium on Wetlands, 1978).

3. Page 51, 59, 60, 64, 66, and 69 - various statements made on these pages with respect to the Roseau River Flood Control Project are inaccurate and we suggest these sections be revised to more accurately reflect only those measures which are authorized and would be undertaken if this project is implemented.

*4. Page 63, 1st paragraph - we suggest that this paragraph be changed to read as follows:

Because of the unacceptable social impacts and the probable limited reduction of flood damages, these nonstructural measures

alone would not be considered viable flood damage reduction alternatives.

However, some of these measures, in combination with other nonstructural measures (such as those previously addressed on page 55), could provide an alternative which could provide a more permanent and long-term solution to many of the flooding problems within the Subbasin.

- * 5. Page 67, Table 16 - the letter symbols designating the impacts of channel improvements and levees on land use and biology should be MoA (Moderately Adverse) and MaA (Maximally Adverse), respectively, and not MoB and MaB as indicated in the Table (see page 66).
- * 6. Page 76, BIBLIOGRAPHY - include the following reference on this page:

National Wetlands Technical Council, 1978. Scientists' Report, National Symposium on Wetlands. 129 pp.

These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.) and are consistent with the intent of the National Environmental Policy Act of 1969.

Sincerely,

Richard F. Berry
Richard F. Berry
Field Office Supervisor

cc: Minn. DNR, St. Paul
S. Bittner, Gulf South Res. Inst., New Iberia

U.S. Army Corps of Engineers
North Central Division
Comments on the
Draft Roseau River Subbasin
June 1980

<u>Cmt. No.</u>	<u>Comment</u>
1.	Figure II is a poor map cartographically. There needs to be a legend which clearly describes the patterning used to delineate the 100-year floodplain, marshy areas, etc.
2.	Would suggest modifying the explanation of nonstructural measures. Would suggest incorporating the following thoughts. Nonstructural measures modify the susceptibility of land, people, and property to damage and losses. In addition, they modify the impact of flooding upon people and communities. Nonstructural measures do not attempt to modify the behavior of floodwaters.
3.	Add a discussion of the National Objectives (NED & EQ) as established by P & S.
4.	The list of objectives is basically good but awkwardly written. Would suggest rewriting such as below. Enhance the recreational opportunities in the Roseau River subbasin for the benefit of the local people.
5.	The assessment and evaluation sections need to emphasize how each alternative meets or doesn't meet each objective--both study objectives and National Objectives.
6.	Pages 6-11. Flood Damages. Since the writer went to the trouble of explaining the two types of flooding--overbank and overland - this discussion of flooding should stipulate which type caused the majority of the flooding. Also, if due to rainfall (and not snowmelt), the amount of rainfall should be disclosed. Add.
7.	Pages 18-19. Social Characteristics. The discussion of social characteristics should go beyond mere numbers and begin describing the social environment in terms of trends, quality of life, and specific problems. A good social record of community are the newspapers. Suggest a diachronic analysis of newspaper contents. Add no later than Stage 2. Add.

<u>Cmt. No.</u>	<u>Comment</u>
8.	Page 74. Evaluation. This section should be retitled "Recommendations" and include a definite statement whether to terminate or proceed. The present discussion simply is not clear. Finally, remember that the nonstructural analysis must be carried beyond Stage 1. Add.
*9.	Page 64. There are current updates to the 1971 Roseau River subbasin report (two supplements to the GDM) which should be included in this assessment. The B/C ratio has also been revised to 1.20 under the 3½% interest rate. Include as reference and discussion these recent updates and supplements.
*10.	Page 14. Wastewater Management. Has the treatment facility at Wonnaska been placed in operation? The report should be updated to 1980.
11.	Page 28. What is the status of the catfish fishery in Hayes Lake?
*12.	Page 71, "Additional Studies Needed", comment 16. From a hydrologic-hydraulic standpoint the need for adequate studies to answer this question cannot be overstated. This should include impacts on discharge-frequency relationships due to levee or channel work.



444 Lafayette Road, Space Center Bldg., St. Paul, MN 55101

PHONE 612/296-4800

File No. _____

July 10, 1980

Colonel William W. Badger
St. Paul District Engineer
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

COMMENTS ON ROSEAU AND TWO RIVERS SUBBASIN REPORTS

The Department of Natural Resources, Division of Waters, has reviewed the above referenced documents. Both documents provide a good overview of the flooding problems and some of the other problems and needs in the basins.

During the review process several problems were identified. On page 56 of the Two Rivers Subbasin Report the discussion of the channel improvements measure states that the backwater effects of the Red River and the cross-over flow from the Roseau Subbasin were not considered in the development of costs and benefits for the alternative. Since these are both significant effects in the Two Rivers Subbasin it would seem to be necessary to evaluate both of these factors before the construction costs and the level of protection provided by the measure could be determined. If this same procedure was used in the evaluation of channel improvements in other subbasins, these measures should be checked again to determine whether or not the benefits and costs assigned to the channel improvement measures are still valid.

We note with interest that on page 64 of the Roseau River Subbasin Report, it states that the updated benefit cost ratio of the authorized project on the Roseau River is now .89. Does this updated figure assume a higher interest rate than was used for project authorization or have costs actually risen enough to reduce the B/C ratio from 1.25 to .89? What are the implications for project implementation?

My last comment is with regard to the additional study needs on pages 70-72. It is quite surprising to see all of the data deficiencies listed for the Roseau River Subbasin. One would intuitively suspect that this subbasin would have a greater quantity of high quality data because of all the planning that has been done for the authorized project on the Roseau River.

While it seems probable that the authorized project on the Roseau River will be constructed, it does not appear as though most other subbasins will be similarly protected. Because of the apparent lack of feasible federal projects, and the general lack of data, it seems that the Corps could best direct its

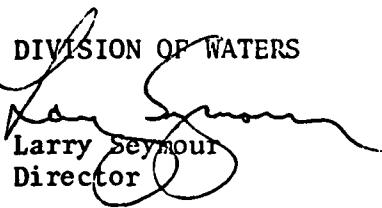
Colonel William W. Badger
Page 2
July 10, 1980

future efforts to the collection of hydrologic and hydraulic data; damage data; and data on storage potential in small reservoirs, drainage ditches and wetlands as well as an overall modelling effort. The provision of data such as this might allow state and local governments and individuals to begin to identify appropriate measures for localized protection in cases where no substantial federal interest is apparent.

Thank you for the opportunity to comment on these documents. If you have any further questions, please contact Joe Gibson at 296-0438 or Ron Harnack at 296-0440.

Sincerely,

DIVISION OF WATERS


Larry Seymour
Director

LS/JG:ph

cc: Joe Gibson
Ron Harnack
Gerry Paul
Roseau River Watershed District

General Comments
Roseau River Subbasin Draft Report
(April 1980)

(These comments apply to the entire report and all subsequent subbasin documents.)

1. As indicated in the specific comments, this document needs additional detailed information concerning nonstructural alternatives. The overall report should address and clarify this aspect of flood damage reduction planning.

2. Comments from Federal, State, and local agencies and a letter from the St. Paul District will be included in an appendix in each final subbasin and in the overall report. The format for the appendix will be:

a. Introduction - This section should stress:

- (1) The importance of completing the study on time.
- (2) That the purpose of the study is to advise other agencies and interests.
- (3) The need for a selected review by various interests to provide complete and factual documentation.
- (4) The use of the study as a building block for future water resource efforts.
- (5) That cooperative efforts to evaluate results and develop solutions to remaining problems will be incorporated.
- (6) A complete public involvement program when the study is finished.

b. The distribution list.

c. Copies of letters of comment.

Only comments that identify significant errors or need specific attention will be addressed in the final subbasin report. However, all comments incorporated should be identified with a marking system. The distribution list for the Roseau River Subbasin Report is given below:

<u>Agencies receiving draft report</u>	<u>Date sent</u>	<u>Date comments received</u>
Federal		
Soil Conservation Service	17 Jun 80	20 Jun 80
Fish and Wildlife Service	17 Jun 80	29 Jul 80
Corps of Engineers, North Central Div.	17 Jun 80	18 Jul 80
Corps of Engineers, St. Paul District	17 Jun 80	20 Jun 80

State

Water Planning Board	17 Jun 80	-
Department of Natural Resources	17 Jun 80	7 Jul 80
Planning Agency	17 Jun 80	-
Water Resources Board	17 Jun 80	-

Local

Civil Defense Director	17 Jun 80	-
Roseau River Watershed District	17 Jun 80	-

3. The source for most information identified in the majority of the tables is Gulf South Research Institute. If other sources were used, an appropriate reference should be made.

4. The evaluation section of each report is primarily the recommendations of the document. Generally, only the structural alternatives which have a benefit-cost ratio greater than 1.0 are presented. Little attention is given to the other structural and nonstructural alternatives. These alternatives may be an important aspect of future flood damage reduction planning for either the subbasin or the overall basin. Some of these alternatives may provide the necessary environmental conditions to warrant further study. Therefore, this section should be expanded to provide the appropriate discussions.

5. Rather than stating in each report and for each alternative evaluated that there will be little or no effect on cultural resources, the report should indicate that it is not possible to identify effects on cultural resources until a systematic cultural resource survey has been completed in the subbasin. Such statements are misleading because the report implies that no significant sites are in the subbasin. In reality, there are simply no known sites, and the document and tables should be modified, as appropriate.

6. The supporting information for alternatives including technical, economic, and any environmental data should be provided (at least under separate cover). This would simplify matters when questions are asked during review or in the future.

7. The maps should have more detail. Often information in the text is not clearly illustrated in the maps. The maps would be improved if reproductions were of better quality and included township lines or relationships of the subbasin to county or State lines.

Specific Comments
Draft Roseau River Subbasin Report
June 1980

- * 1. Page 2 - Reference 3 introduced "the preliminary report mentioned in No. 8." It is not "the preliminary report mentioned above."
- * 2. Page 2, references 2 and 3 - Delete the word "preliminary."
- * 3. Page 2, reference 5 - Although the Environmental Impact Assessment includes a section on archeological sites, its primary objective is to include all environmental aspects of the subbasin.
- * 4. Page 3, first paragraph - Because of the sentence "The area is unique because it is one of the two subbasins that reaches into Canada," the following statement sounds as if the formation of the Roseau River Watershed District was also unique. This is not the case.
- * 5. Page 3, 1st paragraph, last sentence - Replace "on" with "the" before International Joint Commission.
- * 6. Page 5, last paragraph - Roseau is referred to as a village. It should be referred to as a city.
- * 7. Page 5, last paragraph - Perhaps some mention should be made regarding channel depth versus discharge. For example: "Water depths can be significantly lower than channel depths during low flows."
- * 8. Page 7, 2nd paragraph - Second sentence should read: "... half of the area within the United States portion of the subbasin is under cultivation."
- * 9. Page 9, last paragraph - Should the first sentence state that the primary areas are urban, agricultural, and environmental if there is only one urban area in the subbasin that is subject to flooding and it accounts for only 8 percent of the total average annual damages in the subbasin?
- * 10. Page 10, last paragraph - Insert "million" after \$21.7.
- * 11. Pages 10 and 11, Tables 1 and 2 and the paragraphs related to these tables - The data concerning average annual damages are outdated. A reanalysis of the economics of the Roseau River project was done in January 1979 by our Economics Section. Data from this unpublished report supercede the data in the 1977 Red River Basin Plan of Study. The following summarizes present condition (1980) average annual damages, expressed at an October 1979 price level:

<u>Category</u>	<u>Average annual damages</u>
Urban	\$230,000
Residential	(103,500)
Commercial	(103,800)
Public	(22,700)
Rural	1,068,000
Crop	(759,300)
Other agricultural	(269,400)
Transportation	(39,300)
Total	1,298,000

(1) Gives no credit to existing emergency levee sources: 1978 Economic Reanalyses of Roseau River Project (unpublished), Post Flood Report...

- * 12. Page 11, last paragraph - In the discussion of the data from the Minnesota Land Management Information Service, what the 50.5 percent represents has been left out.
- * 13. Page 11, last paragraph - Because land use changes in the subbasin are rapid and MLMIS is not frequently updated, the date of the information should be included.
- * 14. Page 12, first sentence - Replace the word "save" with "serve."
- * 15. Page 12, first paragraph - The statement: "(high augmentation of flows would assist)" assumes that augmentation would be feasible. This is highly unlikely. Delete the statement.
- * 16. Page 12, Recreational Problems - Water quality does not limit recreation in the Roseau River.
- 17. Page 12, Recreational Problems - A statement on recreational demand should be included. If demand is low, there may not be a problem.
- 18. Page 12, Recreational Problems - The current information on fishery conditions for Hayes Lake should be included if possible. DNR fisheries people should have that information. (Also page 37.)
- * 19. Page 13, top - Low flows occur frequently in the Roseau River, but flows are not intermittent.
- * 20. Page 13, Erosion Problems - Add at the end of the first sentence "and low gradient."
- * 21. Page 13, Erosion Problems - Omit the reference to sandy areas or quantify the amount. As written, it sounds like a major problem and that is not the case.

22. Page 14, 5th paragraph - Badger is the only community that discharges into the Roseau River. Should the other two communities be mentioned?

* 23. Page 16, 1st paragraph - Public perception of problems and solutions may be adequately defined for a reconnaissance report for the subbasin, but "well defined" may be too strong a statement. It appears to contradict No. 7 under additional study needs.

* 24. Page 17, last paragraph - Change sentence "...it is evident that residents of the Red River Basin consider flood control..." to read "...it is evident that most residents of the..."

25. Page 18, last paragraph - "Almost 94% of the work force..." Page 21, first paragraph - "...manufacturers in Roseau County... employ... 1,500 people." Table 5 - Transportation equipment - 600. Since Polaris Division of Textron, Inc., in Roseau has laid off half of its work force and will not be reemploying anyone until after sales pick up, this factor should be mentioned in one of the above sections. Also, the term "close knit" should be explained.

26. Page 19, Income - Comparing the 1977 per capita income of \$6,892 as being "20 percent below" average State figures for 1979 is not adequate. The comparison should be made between the percent increase of per capita income for the subbasin from 1969 to 1977 (of 40 percent) and the percent increase of per capita income for the State from 1969 to 1977 (36 percent).

27. Page 19, Income - The distribution of income (such as percentage of population below the poverty level, etc.) should be included.

28. Page 20, Agriculture - Several additional facts would aid in better understanding the relative importance of each crop. These include: gross income per acre for particular crops, the differential in susceptibilities of crops to flood damages, and the differential in costs per acre to plant particular crops.

* 29. Page 21, Table 5, Estimated Employment - Do the numbers given indicate people, percent of employment market, or what?

* 30. Page 27, 1st paragraph - WMA should be defined.

* 31. Page 28, 3rd paragraph - Marsh and Adelman (1978) is an improper citation. This report was prepared under a Corps of Engineers contract and should be referred to as such. Also, there is no 1979 reference to the U.S. Fish and Wildlife Service.

* 32. Page 28, 3rd paragraph - Sauger and rock bass are not common in the Roseau River.

* 33. Page 28, last paragraph - Delete first sentence and insert "in the invertebrate community" after "common" in the second sentence.

- *34. Page 31, 2nd paragraph - "Quite good" water quality should be defined.
- *35. Page 31, 3rd paragraph - Turbidity has not been identified as a limiting factor to the sport fishery resources in the river.
- *36. Page 34, Cultural Elements - Should be consistent in use of BP versus BC or one could be construed as a typing error.
- 37. Page 35 - Table 9 would be more meaningful with allowable limit values given.
- *38. Page 36, 2nd paragraph, and page 39, Cultural - There is a known and recorded historic Ojibwa cemetery at river station 1600+00.
- *39. Page 36, 2nd paragraph - The need for systematic cultural resources surveys in the subbasin could be more strongly stated. Only the area immediately adjacent to the Roseau River has been surveyed.
- 40. Page 37, Social - In addition to the information presented, a discussion of social consequences or implications of flood events should be presented, particularly those concerning behavioral damages that may occur.
- *41. Page 39, Cultural - This section states that there are 16 recorded archeological sites; on page 36, 12 sites are referred to.
- *42. Page 41, Wetlands - The assessment of wetlands in the report of the U.S. Fish and Wildlife Service (1977) is misleading and contains erroneous data. Publication of this discredited data could raise unnecessary questions and should therefore be deleted here and from table 11 on page 42.
- 43. Page 43, Threatened or Endangered Species - The peregrine falcon has been extirpated from Minnesota and may be seen in the subbasin only during its migration.
- *44. Page 43, Threatened or Endangered Species - Insert "Active and abandoned" before the words "nesting sites" in reference to bald eagles.
- *45. Page 44, 2nd paragraph - A clear distinction between the State and Federal endangered species lists should be made. The greater sandhill crane is not on the Federal list but is on the Minnesota list.
- *46. Page 44, 3rd paragraph - Reference to sharp-tailed and ruffed grouse should be deleted from this paragraph. It implies that they are rare or uncommon which is not the case.
- *47. Page 46, 2nd paragraph - "...predicted steady increases..." not "study."
- *48. Page 46, 3rd paragraph - Very few people reside in the portion of Beltrami County that is within the subbasin. Perhaps this should be clarified.
- *49. Page 46, last paragraph - The statement "...manufacturing will continue its predominant role" contradicts statements on page 19 where 50 percent of total personal income is farm income. Also, agriculture accounts for 25 percent of total employment, and services and manufacturing account for another 25 percent.

- * 50. Page 51, 2nd paragraph - As of 17 June 1980 the Roseau River flood control project was not under construction but was in preconstruction planning.
- * 51. Page 51, 2nd paragraph - The statement "one of the best warm water fisheries in the state" is not accurate and should be deleted. This comment also applies to page 66, last paragraph. Under the Without Project Condition Section, the last part of the sentence after "Period" should be deleted.
- 52. Page 52, 2nd paragraph - Although there still may be some concern regarding wetland drainage it appears that conflicts on the project's effects on wetlands have finally been resolved. The Corps recently submitted a Draft Supplement Environmental Impact Statement which discusses project modifications that should prevent induced wetland drainage.
- * 53. Page 53, 3rd paragraph - What is meant by "...a minimum amount of flood protection."
- * 54. Page 55, 2nd paragraph, last sentence - "Natural" is misspelled.
- 55. Page 55, Nonstructural Measures - Do the other towns in the subbasin also have floodplain zoning ordinances, building codes, and subdivision regulations for floodplain areas? Some explanation of the existing situation in these towns would be helpful.
- * 56. Page 57, 3rd paragraph - The second sentence should read "Tangible economic benefits or appropriate gains in environmental quality must exceed overall costs."
- * 57. Page 57, Planning Objectives - The second paragraph seems to be too strong. The following rewrite is suggested: "The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin from the information that was available. On the basis of this analysis of the problems, needs, and desires that could be identified, the following objectives were established."
- * 58. Page 59, 2nd paragraph - Ditches will not be improved as part of the project. References to this feature should be deleted.
- * 59. Page 59, last paragraph - Any decrease in flood damages on the 22,000 acres below Big Swamp is because the floods are reduced in that portion of the area. Also, the remainder of the paragraph is not correct. Roseau River channelization maintains the overflow into the Two Rivers basin at preconstruction levels. Flows to Canada are altered which necessitates mitigation payment to Canada. Reduction of Roseau River flood flows into the Two Rivers basin would increase flood flows to Canada.
- 60. Page 61, Reservoir Storage - The brief discussion of the two reservoir alternatives should include the principal reasons the benefit-cost ratio is unfavorable.
- * 61. Page 62, Alternative Measures - Although the project protects against 10-percent chance floods in rural areas and 50-percent chance floods in Roseau, rare floods could cause serious problems. The same comment pertains to page 64, first paragraph.

- *62. Page 62, Alternative Measures - Replace "...no serious flood problem areas will remain..." with "...no serious flood problem areas should remain..."
- *63. Page 64 - The first paragraph is identical to Alternative Measures, page 62.
- *64. Page 64, 2nd paragraph - Delete (3). See comment 58.
- *65. Page 64, 3rd paragraph - Elaborate on the basis of updating costs and benefits. According to one Corps resource, the project has a B/C of 1.23 with current costs and benefits and the authorized interest rate which is 3½ percent but has a B/C of 0.89 if the current interest rate is used. Actually the sentence on the benefit-cost ratio being 0.89 and the next sentence do not add anything to the report.
- 66. Page 65, last paragraph - Would farmstead levees have such a high benefit-cost ratio in view of the channelization project? It seems this should be different than in other reports.
- *67. Page 66, 2nd paragraph - Reference to improving ditches should be deleted. See comment 58.
- *68. Page 67, Table 16 - Several of the assessments in this table do not agree with verbal statements on the previous page. For example, is biology maximally beneficial (Table 16) or maximally adverse (last paragraph, page 66)?
- *69. Page 68, top of page - No connection between the Roseau and Red River fisheries has been definitely established. This sentence should be deleted.
- *70. Page 68, 2nd paragraph - Adjustments have been made to avoid one of the two sites left in the construction zone; however, the Olson Mound Group will still be affected by the proposed construction.
- *71. Page 68, 3rd paragraph - Mitigation measures for Canada have been determined but have not been negotiated.
- *72. Page 68, Farmstead Levees - With 12 (16?) archeological sites already identified along the Roseau River, farm levees will probably affect some sites.
- *73. Page 69, 3rd paragraph - Should it be said that reservoir storage would be "most adequate" in "preserving, creating, and enhancing environmental quality?" Reservoirs are typically considered environmental disasters. What makes this reservoir so different?
- 74. Page 71, Items 10 and 11 - Each subbasin report should state that the probability of institutional and social boundaries being the same as subbasin boundaries is remote. Because these boundaries overlap, integrated basin-wide social and institutional analyses are desirable.
- *75. Page 71, Items 17 and 18 - These two tasks have already been accomplished. See comment 11.

*76. Page 79, last paragraph - Information is misspelled.

NOTE: Comments 11, 42 and 50 must be incorporated into the final Roseau subbasin report. These involve recent actions or reports which significantly alter statements made in this subbasin report. The report should reflect these changes.

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